677

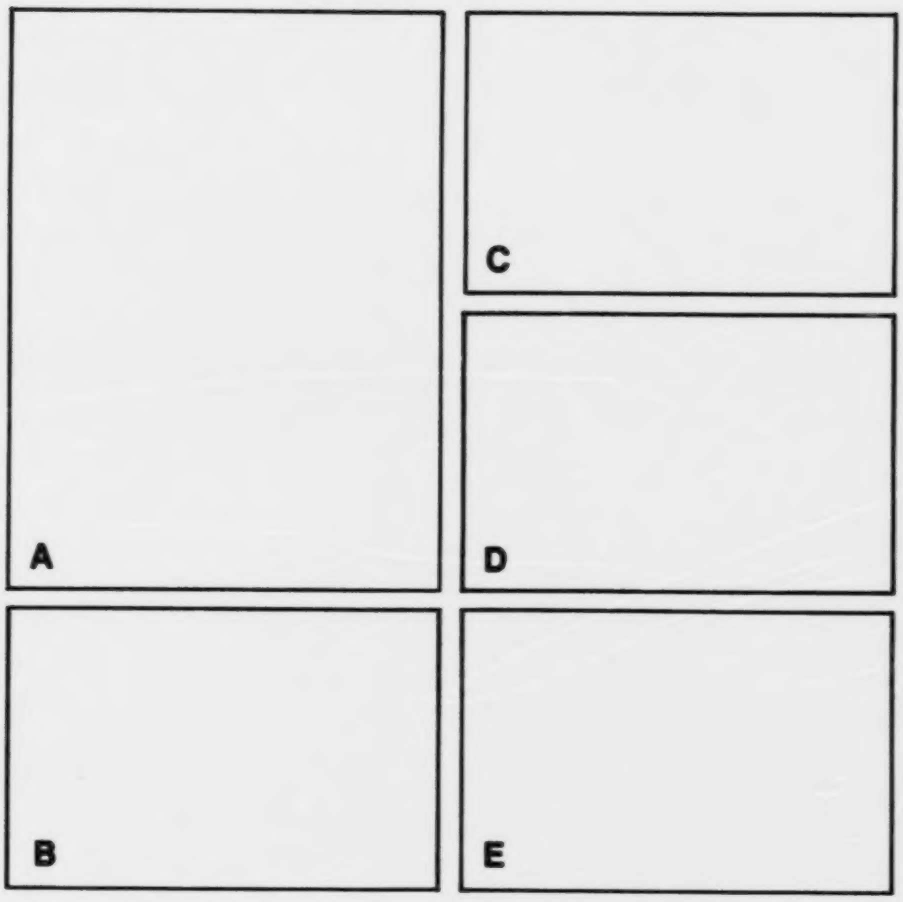
United States
Department of
Agriculture

Forest
Service

Agriculture
Handbook 677

A Guide to Insect, Disease, and Animal Pests of Poplars

A1.76:



A — Leaves of a young plantation-grown hybrid poplar.
B — Plantation of hybrid aspen.
C — Fall color of natural aspen stand.
D — Plantation of hybrid poplars.
E — Natural aspen stand prior to leaf flush.

United States
Department of
Agriculture

Forest
Service

Agriculture
Handbook 677

January 1989

A Guide to Insect, Disease, and Animal Pests of Poplars

Michael E. Ostry, Principal Plant Pathologist; Louis F. Wilson, Principal Insect Ecologist; Harold S. McNabb, Jr., Professor of Forest Pathology; and Lincoln M. Moore, formerly Research Entomologist.

All are associated with the USDA Forest Service North Central Forest Experiment Station except McNabb, who is with the Departments of Plant Pathology and Forestry, Iowa State University.

Ostry, Michael E.; Wilson, Louis F.; McNabb, Harold S., Jr.; Moore, Lincoln M. 1988. A guide to insect, disease, and animal pests of poplars. Agric. Handb. 677. Washington, DC: U.S. Department of Agriculture. 118 p.

Describes and illustrates the major insect, disease, and animal pests of poplars. Provides information on the identification, biology, and control of causal agents. Emphasizes field identification and provides references for further information.

KEY WORDS: *Populus,* intensive culture, plantation management.

Acknowledgments

The authors thank the following individuals — Mark Gleason, Richard Hall, Elwood Hart, Manfred Mielke, Michael Morin, Peter Rush, James Solomon, and Laura Sweets — for their helpful reviews of the manuscript and suggested improvements.

Most of the illustrations in this guide were provided by the authors; however, some illustrations were obtained from others and credits for their use are as follows: J. Solomon for the figures on page 82 left "Life stages and injury of poplar borer," page 86 "Clearwing borer entrance hole," page 87 both figures, page 88 "Injury to branches and larvae of branch borers," page 89 "Adult *O. delongi* feeding on leaf," page 91 all three figures, page 92 bottom left "Wilted shoot caused by sawfly," page 92 top middle "Shoot damaged by sawfly," and page 111 "Foliage damaged by cottonwood leafcurl mite (left) compared to normal foliage (right)"; T. Hinds for the figure on page 43 right "*Cenangium* (diffuse canker)"; J. Pinon for the figures on page 16 top right "Physiological leaf symptoms," page 27 bottom "Leaf blisters," page 33 middle "Leaf puckering"; and P. Grijpma for the figure on page 64 bottom left "Life stages of the satin moth."

Contents

Page

Introduction . . . 7

How to Use the Key . . . 11

Identification Key to Major Insects and Diseases of Poplars . . . 11

Noninfectious Diseases . . . 15

Foliar Diseases . . . 19

Septoria Leaf Spot . . . 19

Leaf Rust . . . 20

Septotinia Leaf Blotch . . . 22

Phyllosticta Leaf Spot . . . 23

Powdery Mildew . . . 24

Ink Spot, Shot Hole . . . 24

Marssonina Leaf Spot . . . 25

Leaf Blister, Catkin Deformity . . . 27

Leaf and Shoot Blight . . . 27

Leaf and Stem Blight . . . 29

Viruses and Virus-like Diseases . . . 33

Leaf Bronzing of Aspen . . . 33

Canker Diseases . . . 37

Septoria Canker . . . 37

Hypoxylon Canker . . . 38

Bark Necrosis, Dieback, "Blackstem" . . . 40

Miscellaneous Cankers . . . 42

Bacterial Canker and Dieback . . . 44

Root and Butt Rot . . . 47

Armillaria Root and Butt Rot . . . 47

Miscellaneous Diseases and Parasites . . . 51

Crown Gall . . . 51

Wetwood . . . 52

Miscellaneous Stem Deformities . . . 53

White Trunk Rot . . . 54

Mistletoe . . . 55

Vertebrate Damage . . . 59

Vertebrate Damage . . . 59

Defoliators and Leaf Feeders . . . 63

Imported Willow Leaf Beetle . . . 63

Satin Moth . . . 64

Sarrothripus Moth . . . 64

Large Aspen Tortrix . . . 65

Mourningcloak Butterfly . . . 66

Leafminers . . . 68

Grasshoppers . . . 69

Viceroy Butterfly . . . 70

Forest Tent Caterpillar . . . 71

Bagworm . . . 72

Fall Webworm . . . 72

Cottonwood Leaf Beetle . . . 73

Variegated Cutworm . . . 75

Leafcurl Midge . . . 76

Poplar Tentmaker . . . 77

Boring Insects . . . 81

Poplar Borer . . . 81

Poplar-and-Willow Borer . . . 82

Poplar Root Girdler . . . 84

Bronze Poplar Borer . . . 85

Cottonwood Twig Borer . . . 85

Southern Clearwing Moth . . . 86

Poplar Clearwing Moth . . . 88

Branch Borers . . . 88

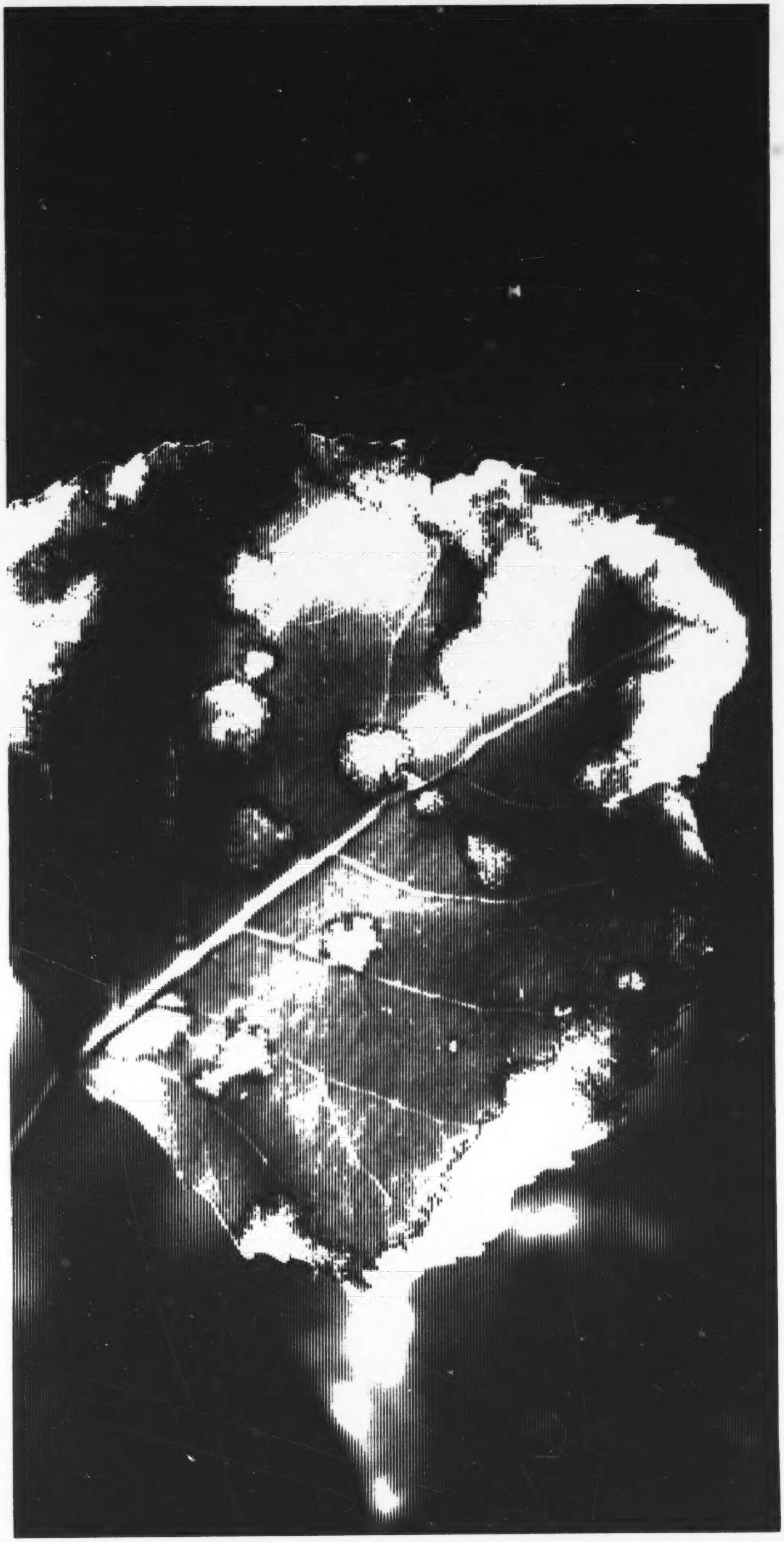
Poplar-Gall Saperda . . . 89

Cottonwood Borer . . . 91

Willow Shoot Sawfly . . . 92

Sucking Insects 95
Poplar Vagabond Aphid 95
Meadow Spittlebug 96
Tarnished Plant Bug 96
Scurfy Scale 98
Oystershell Scale 98
Miscellaneous Leaf-feeding Aphids 100
Spotted Poplar Aphid 101
Leafhoppers 103
Miscellaneous Insects and Mites 107
Gall Insects 107
Snowy Tree Cricket 109
Cicadas 110
Cottonwood Leafcurl Mite 111
Glossary 115
References 116
Forest Service Offices 117

Introduction



Introduction

Poplars are among the fastest growing trees in temperate regions of the world. Intensively managed plantations of genetically superior *Populus* clones can rapidly produce large volumes of wood for fiber and fuel. In addition, poplars are also valuable for nontimber uses such as ornamental plantings, windbreaks, visual screens, and soil stabilizers.

However, many insects and diseases can threaten the success of poplar plantations by reducing productivity and/or quality of affected trees. Frequently insects and diseases, together with other biotic and abiotic agents, either kill trees or prevent them from reaching their potential growth.

Growers of poplars need to be able to identify the cause of a problem should one develop. Once they know the cause, growers are better able to answer the following questions:

1. What is the expected impact of this condition?
2. Will this condition change my management plans and goals?
3. Are control measures warranted?
4. What control measures are available?

Although there are several hundred insect pests and pathogens of poplars, only a few of them are potentially dangerous. We have emphasized insects and pathogens that are most likely to be important in poplar plantations in North America. References are provided for obtaining additional information on the major insect pests and diseases.

As poplar culture becomes more intense and widespread, increased exchange of breeding and planting stock may introduce additional insect pests and pathogens into North America. Many of these are destructive elsewhere and could become destructive here as well. For this reason we have included descriptions of the major pathogens elsewhere in the world that could threaten poplar production here unless growers guard against their accidental introductions.

In this guide, we suggest management strategies to minimize injury to trees by insects and disease agents. Direct chemical control is usually not warranted or possible except in nurseries, either because it is not economically feasible or because no chemical is currently registered for use in controlling a specific insect or disease. We advise growers to consult their State and County extension agents for current recommendations because of possible changes in pesticide laws, rates, formulations, and application methods.

Populus is a genus rich in genetic diversity. In addition to the many species of poplars, many interspecific and intraspecific hybrids have exhibited resistance or tolerance to several of the major insects and diseases in this guide. However, growers must be aware that many commercially available clones are extremely susceptible to certain insect pests and diseases, making them highly undesirable for most uses. Most of these clones have not undergone field testing in all the locations where they are now being planted, so their pest resistance under different growing conditions is unknown.

In this guide, where we have research data, we make recommendations for or against poplar species or clones with parentages that have exhibited resistance or susceptibility to serious insect and disease injury. We encourage growers to test several clones in their area before planting large numbers of trees.

To identify accurately the cause of an injury, a grower must first carefully examine trees exhibiting abnormalities such as off-color foliage, missing foliage, branch dieback, and cankers. These are *symptoms* of insect infestations and diseases. Note the part of the tree that is affected (for example, lower trunk, upper branches, young shoots, etc.) and the time of year when symptoms develop. Take note of the proportion of trees that are affected and whether there is a pattern of affected trees. For example, are trees with the same symptoms grouped or scattered throughout the planting? Try to find *signs* of the causal agents such as fungus fruit bodies, insects, webs, and eggs, on or next to the injured tissues. For individuals with access to a microscope, illustrations of spores are included in the descriptions of fungi that cause similar symptoms. Because a complex of factors is often involved, take care in attempting to diagnose the primary cause of injuries.

After carefully examining the affected trees, use the illustrations, descriptions, and the descriptive key in this guide to identify various injurious agents. In some cases injuries resulting from several different agents are so alike that it is difficult to distinguish the exact cause. If you can't make positive identification after using this guide, consult a forest entomologist or forest pathologist. Pest management information can be obtained from the Forest Service offices listed on page 117.

How to Use the Key

Identification Key to Major Insects and Diseases of Poplars

How to Use the Key

1. Carefully examine the injury, noting any major symptoms or signs.
2. Look under the appropriate headings in the key for the part of the tree and type of injury you are trying to identify.
3. Compare the descriptions and illustrations with your observations.

Identification Key to Major Insects and Diseases of Poplars

- I. Injury to Cuttings or Seedlings
  - A. Failure of unrooted hardwood cuttings to flush or shoots quickly die.
    - 1. Cuttings shriveled, blackened, with "pimple-like" structures on surface.
      - Blackstem, p. 40.
  - B. Shoots severed at soil surface.
    - 1. Cuttings not blackened.
      - Variegated cutworm, p. 75.
- II. Injury to Foliage
  - A. Leaves eaten.
    - 1. Webbing present on branches.
      - a. Large webs (up to 3 feet in diameter).
        - Fall webworm, p. 72.
      - b. Small-large bags or tents.
        - Bagworm, p. 72.
        - Poplar tentmaker, p. 77.
    - 2. No webbing present.
      - Satin moth, p. 64.
      - Forest tent caterpillar, p. 71.
      - Viceroy butterfly, p. 70.
      - Grasshopper, p. 69.
      - Mourningcloak butterfly, p. 66.
      - Cottonwood leaf beetle, p. 73.
  - B. Leaves not eaten.
    - 1. Young leaves withered, may droop, later turn black.
      - a. Generally present throughout trees in planting, no necrotic blotches on adjacent leaves.
        - Frost injury, p. 15.
      - b. Scattered or more prevalent on groups of trees, necrotic blotches on leaves.
        - Venturia leaf blight, p. 27.
        - Alternaria leaf blight, p. 29.
    - 2. Leaves with large, irregular blotches, with or without concentric rings, usually not limited by veins.
      - a. Large areas of leaves turn light brown in early summer, later dark brown-black "ink spots" develop within affected area.
        - Ciborinia ink spot, p. 24.
      - b. Leaves in lower crown have brown-gray blotches and white concentric rings.
        - Septotinia leaf blotch, p. 22.
      - c. Leaves with brown to whitish-gray blotches and small black dots (fruit bodies) within.
        - Phyllosticta leaf blotch, p. 23.
      - d. Leaves with patches of white-gray powder.
        - Powdery mildew, p. 24.
      - e. Leaves distorted, skeletonized.
        - Imported willow leaf beetle, p. 63.
        - Sarrothripus moth, p. 64.
      - f. Leaves with blisters, galls, or mined areas of various sizes and shapes.
        - Taphrina leaf blister, p. 27.
        - Leafminers, p. 68.
        - Gall insects, p. 107.
    - 3. Leaves with small spots, often later coalescing into small, irregular blotches, generally limited by veins.
      - a. Circular spots reddish with a chlorotic halo early in season, later turning dark brown, often with a whitish raised center. Undersides of severely affected leaves bronze in color.
        - Marssonina leaf spot, p. 25.
      - b. Spots generally larger and more angular than above, occasionally irregularly shaped tan blotch bordered by a dark brown margin.
        - Septoria leaf spot, p. 19.
      - c. Yellow-orange spots, later forming an orange powdery mass on undersides of leaves.
        - Melampsora leaf rust, p. 20.
    - 4. Leaves misshapen, chlorotic, stunted.
      - a. Leaves with various mosaic or mottled chlorotic patterns.
        - Virus diseases, p. 33.
        - Leafhoppers, p. 103.
      - b. Leaves stunted, "burned" appearance.
        - Chemical injury, p. 15.
      - c. Leaves crinkled, missing on terminal shoots.
        - Cottonwood leafcurl mite, p. 111.
      - d. Terminal shoots and leaves covered with colonies of aphids.
        - Brown aphid, p. 100.
        - Spotted poplar aphid, p. 101.
    - 5. Leaves folded.
      - Leafcurl midge, p. 76.
    - 6. Leaves tightly rolled.
      - Large aspen tortrix, p. 65.

- III. Injury to Shoots
  - A. Elongating shoots injured in early spring.
    - 1. Shoots curled, leaves wilted, terminals resemble a shepherd's crook.
      - a. Shoots and leaves black.
        - Venturia shoot blight, p. 27.
        - Frost, p. 15.
      - b. Shoots and leaves green or black, wilted.
        - Willowshoot sawfly, p. 92.
    - 2. Frothy spittlemass on terminals.
      - Meadow spittlebug, p. 96.
    - 3. Shoots swollen, irregular scars along shoots, dead or dying terminals.
      - Cottonwood twig borer, p. 85.
      - Tarnished plant bug, p. 96.
      - Southern clearwing moth, p. 86.
    - 4. Large, irregular, green or brown galls on terminals.
      - Poplar vagabond aphid, p. 95.
  - B. Terminal shoots missing.
    - 1. Small tree branches and shoots cleanly cut off near ground line.
      - Rabbit, p. 59.
    - 2. Upper shoots of small trees nipped off, leaving a ragged end.
      - Deer, p. 59.
- IV. Injury to Branches and Trunk
  - A. Bark removed or hanging in shreds on stems.
    - 1. Bark hanging in shreds, no teeth marks on exposed wood.
      - Deer, elk, moose, p. 59.
    - 2. Bark not hanging in shreds, teeth marks on exposed wood.
      - Rodents, p. 59.
    - 3. Bark split away, exposing wood at base of tree, usually on the southwest side.
      - Sunscald, p. 15.
  - B. Cracks, deformities, dieback, fruit bodies.
    - 1. Depressed, dark central area often with cracks.
      - Septoria canker, p. 37.
    - 2. Yellowish-orange areas, often with many raised pimple-like structures (fruit bodies). Bark usually intact, often rough on older trees.
      - *Cytospora, Dothichiza, Phomopsis,* p. 40.
    - 3. Target-shaped rings of dead bark.
      - Miscellaneous cankers, p. 42.
    - 4. Yellowish-orange to black, slightly depressed areas, blistering bark with gray pegs or gray-black cushion-like structures.
      - Hypoxylon canker, p. 38.
    - 5. Hoof-shaped conks along upper stems of pole-size and larger trees.
      - White trunk rot, p. 54.
    - 6. Slime flux originating from a wound or branch stub, running down side of trunk.
      - Wetwood, p. 52.
    - 7. Tumor-like growth, warty appearance, large galls.
      - *Agrobacterium,* p. 51.
      - Bacterial canker, p. 44.
      - Miscellaneous stem deformities, p. 53.
    - 8. Holes in bark with sap, wood shavings, and frass present.
      - Poplar borer, p. 81.
      - Poplar-and-willow borer, p. 82.
    - 9. Tunneling at base of stem.
      - a. Sap flow and wood shavings present.
        - Poplar clearwing moth, p. 88.
      - b. Swollen galleries encircling base.
        - Poplar root girdler, p. 84.
      - c. Frass in root collar and main roots.
        - Cottonwood borer, p. 91.
    - 10. Slits on branches up to 3 inches long.
      - Cicada, p. 110.
      - Snowy tree cricket, p. 109.
    - 11. White-brown crust on bark surface.
      - Scurfy scale, p. 98.
      - Oystershell scale, p. 98.
    - 12. Branch and stem swellings.
      - a. Clumps of green plants present.
        - Mistletoe, p. 55.
      - b. Scars or holes present on swellings or galls.
        - Oberea branch borers, p. 88.
        - Bronze poplar borers, p. 85.
        - Poplar-gall saperda, p. 89.
        - Gall insects, p. 107.
    - 13. Root and butt rot.
      - Armillaria root rot, p. 47.

Noninfectious Diseases

Noninfectious Diseases

Sunscald, Frost, Chemicals, Air Pollution, Heat, Flooding, Drought

Importance — Noninfectious diseases, depending on their cause and severity, can result in premature defoliation, stem injuries, branch dieback, predisposition to pathogens and insects, and tree death.

Look For —

- Off-color, chlorotic, or necrotic foliage.
- Patches of dead bark, usually on the south side of the tree.
- Wilted foliage, branch dieback.
- Premature defoliation.
- Distorted leaves.

Noninfectious diseases produce many different symptoms. Often these symptoms may resemble those produced by insects, fungi, or other biotic agents. Careful observation and knowledge of the management history, including any chemical treatments applied, are needed to distinguish those diseases caused by abiotic factors from those caused by biotic agents.

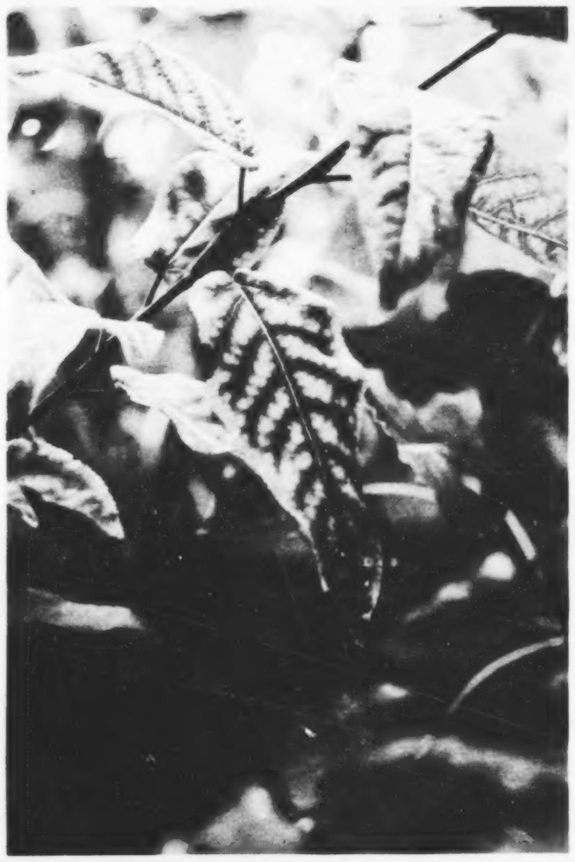
Chemical damage (herbicide).

Chemical damage (herbicide).

Chemical damage (herbicide).

Biology — Noninfectious diseases are those not caused by fungi, bacteria, viruses, or nematodes. Instead, they result from extremes in temperature, water supply, chemicals (both in the air and soil), nutrient imbalances, soil compaction, or various mechanical injuries. Herbicides and fertilizers that are improperly used can damage trees.

Monitoring — Observe trees for symptoms of damage that cannot be associated with biotic agents. Carefully examine trees after severe weather or after chemical or cultural treatments. Stressed trees are often infected by fungi or attacked by insects.



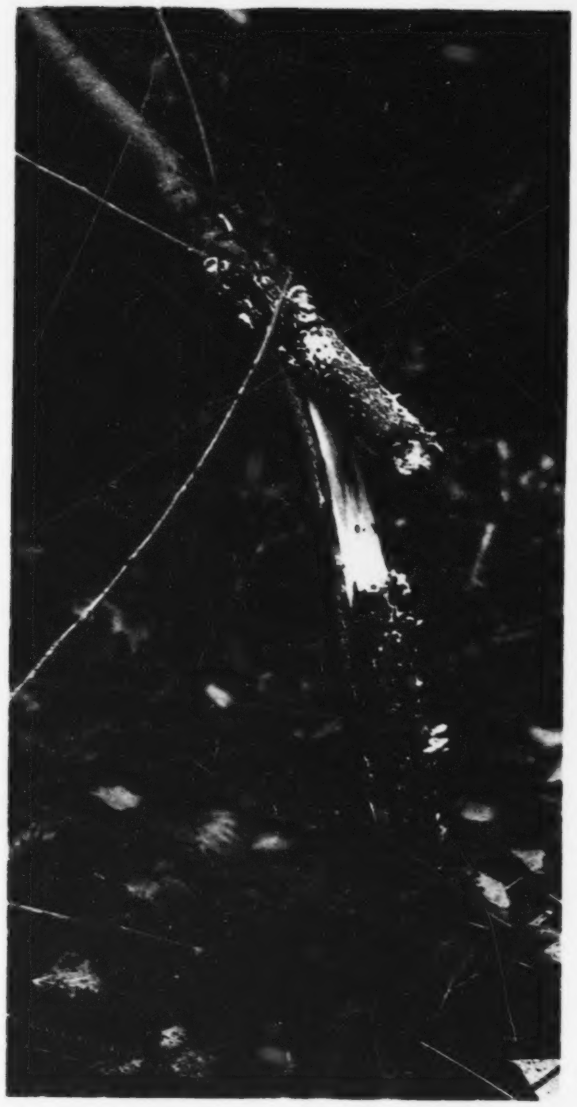
Nutrient imbalance.

Control —

- Prevention is usually the best control.
- Plant poplars on sites that will allow good tree growth and avoid stress-related diseases.
- Provide adequate water, nutrients, and weed control.
- Apply herbicides carefully to avoid damaging poplars.

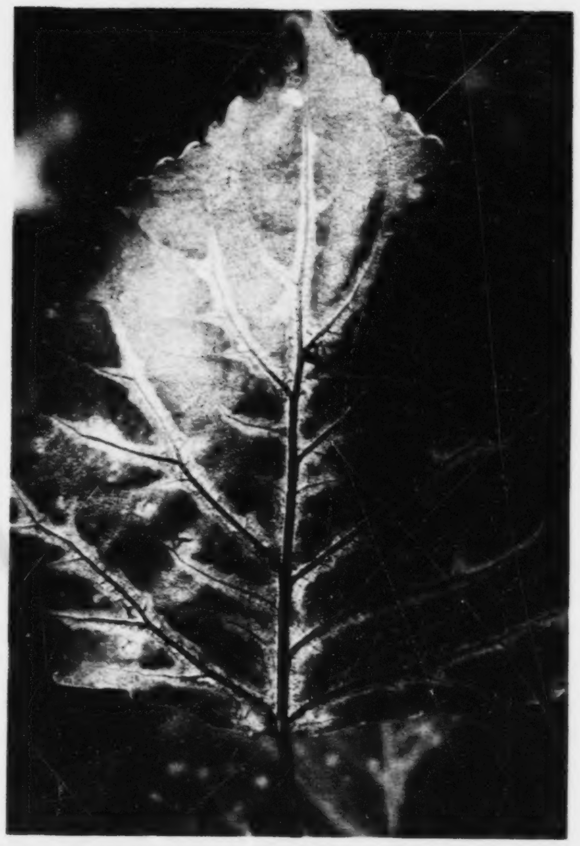
For Additional Information — The causes of noninfectious diseases are often complex and difficult to diagnose. If you can't determine the cause for a particular condition, contact your county, forestry, or plant pathology extension office.

Sunscald.



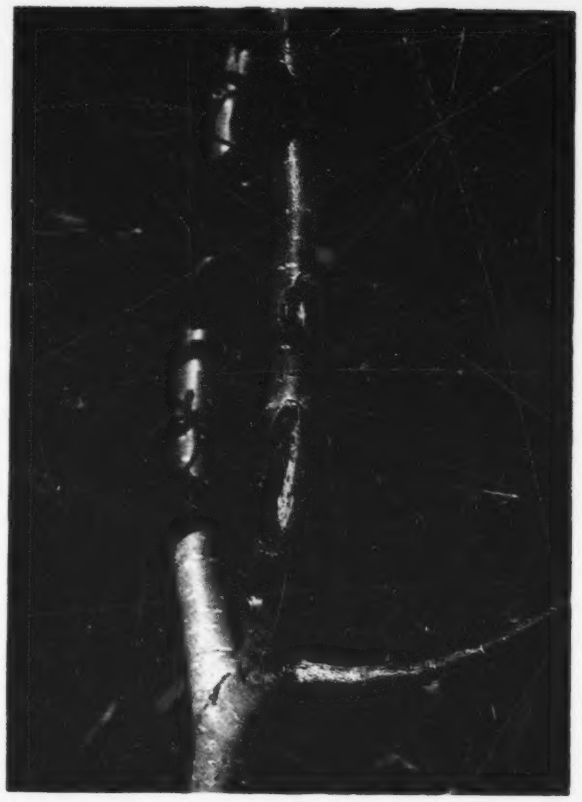
Stem breakage at sunscald. Note decay fungi fruiting on affected area.

Frost damage to new shoot.



Physiological leaf symptoms.

Frost damage to leaves.

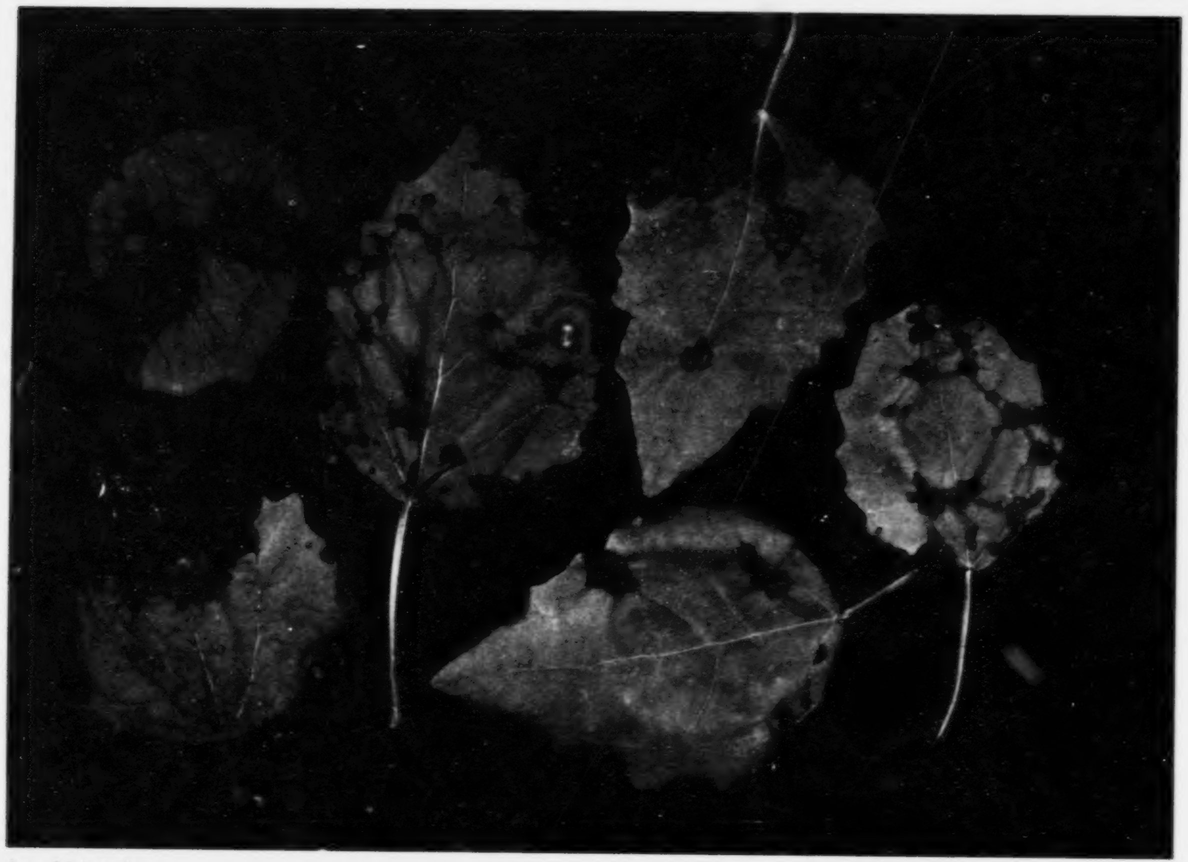


Hail damage.

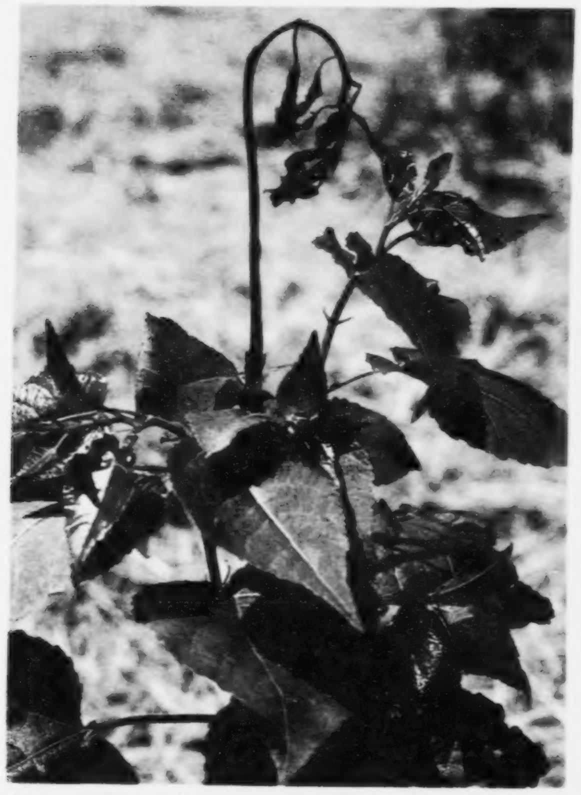
Drought stress. Note sparse foliage.

Foliar Diseases

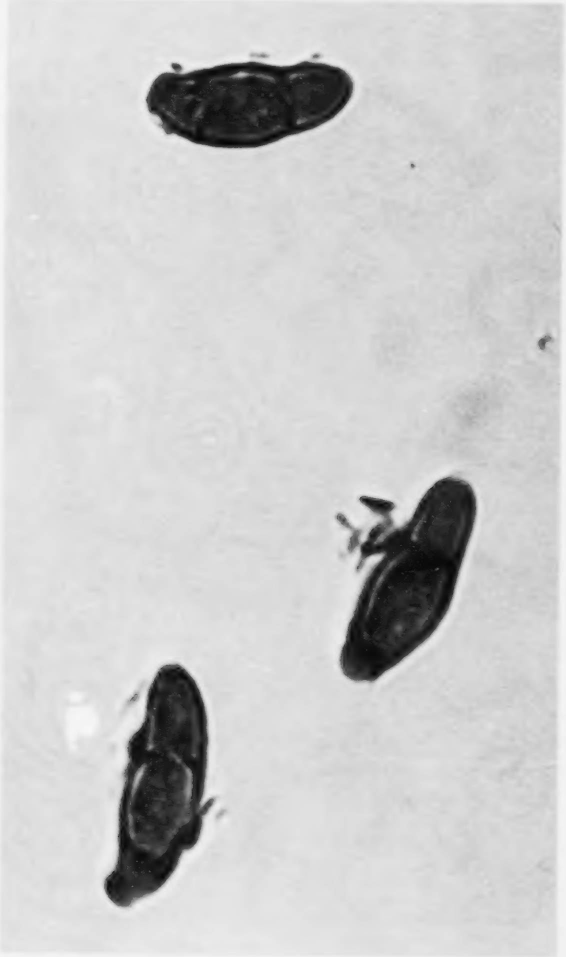
Ostry, Michael E. 1980. How to identify shoot blight of poplars. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 5 p.



Leaf blotches.



Diseased shoot.



Conidia.

Leaf and Stem Blight (*Alternaria tenuis*)

Importance — Usually of minor importance, Alternaria leaf blight can be severe on lower shaded leaves in dense plantings. The fungus also can infect unrooted softwood cuttings in nurseries.

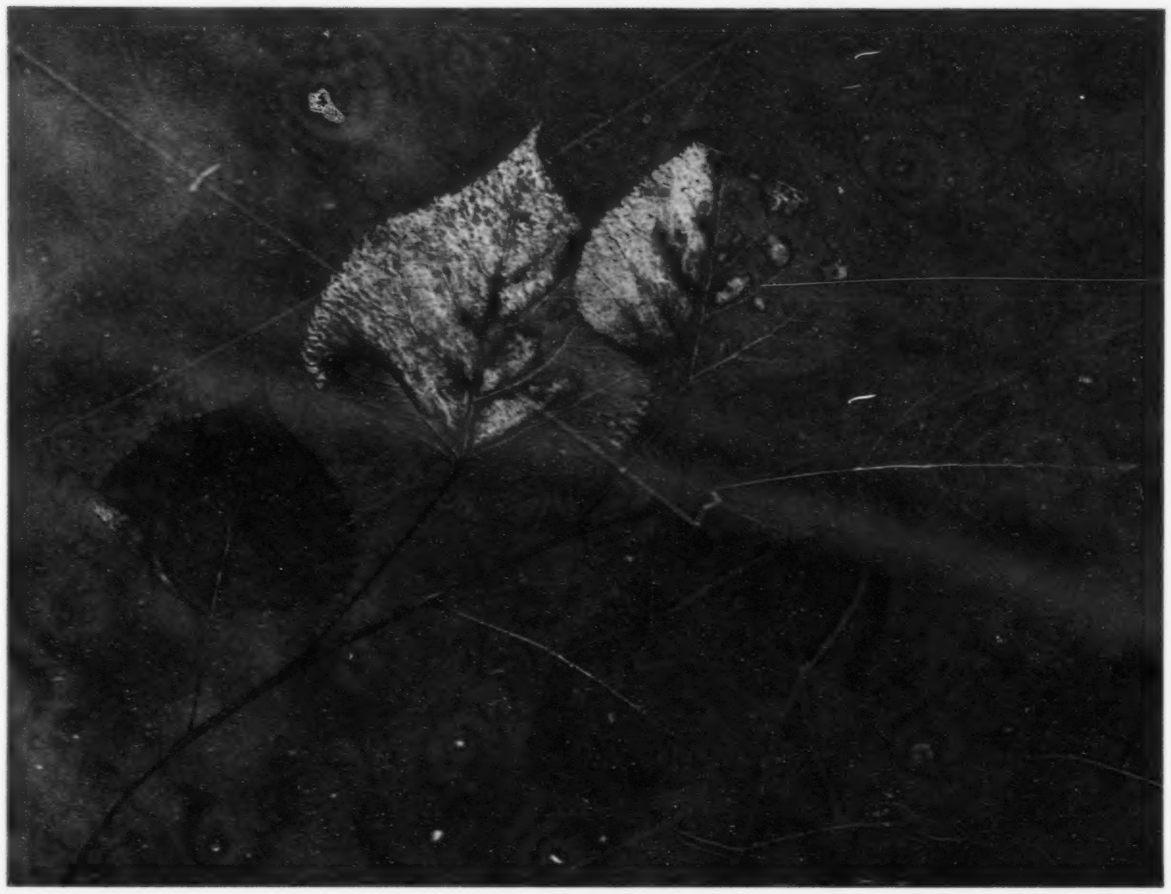
Look For —

- Sooty, irregular-shaped spots and blotches, usually near leaf margins.
- Black stems and leaves of softwood cuttings.

Biology — *Alternaria* overwinters on infected plant debris. The fungus, in addition to directly infecting leaves, also invades tissues wounded by various insects.

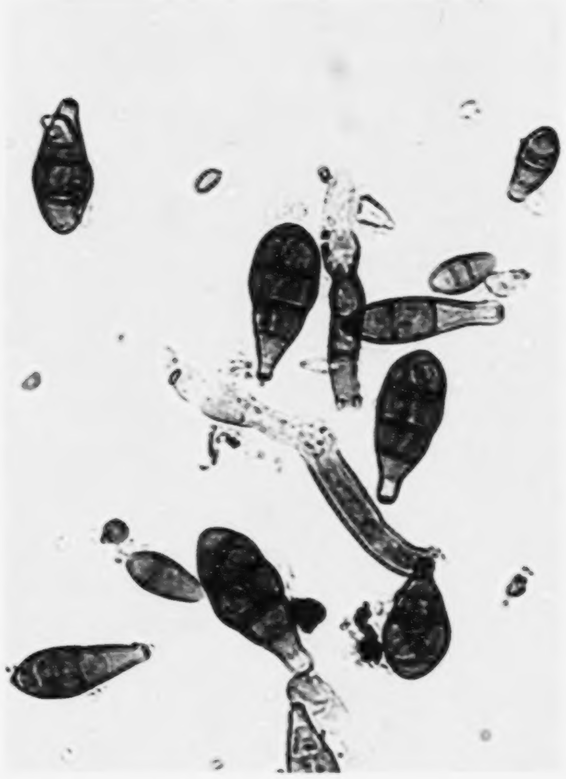
Control —

- Remove infected leaf debris to reduce inoculum and minimize disease.
- Apply a fungicide in nursery rooting beds if needed.



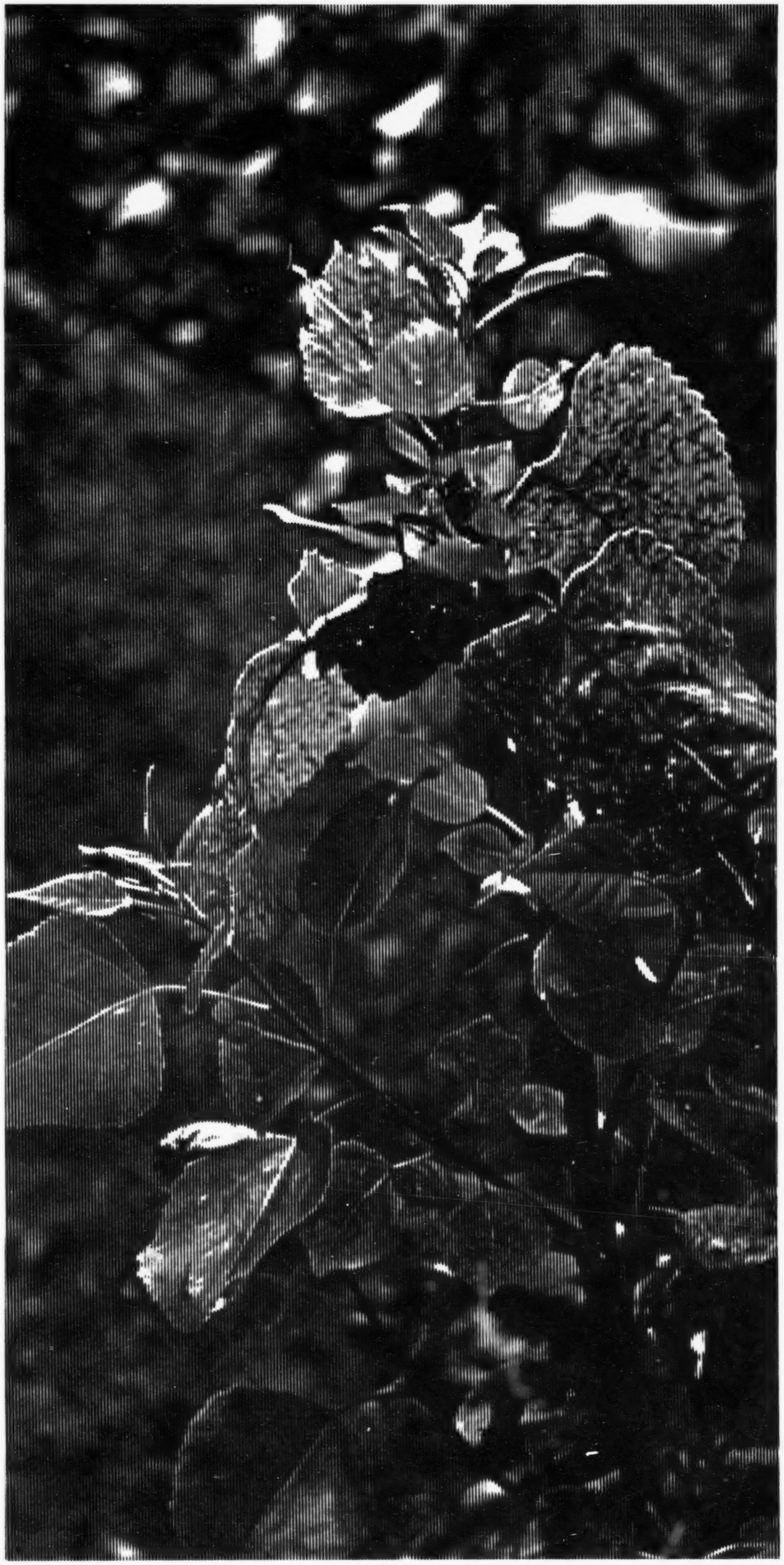
Diseased leaves.

Shaded lower leaves colonized by Alternaria.



Conidia.

Viruses and Virus-like Diseases



Viruses and Virus-Like Diseases

Leaf Bronzing of Aspen (Viruses, Mycoplasmas, Rickettsia, Spiroplasmas)

Importance — These systemic pathogens cause degenerative diseases that can result in diebacks, declines, and reductions in growth and yield potential.

Look For —

General:

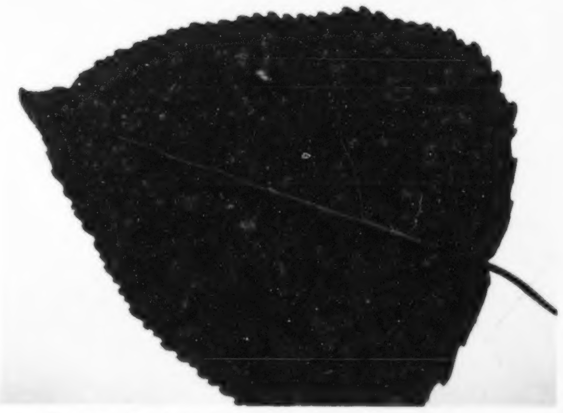
- Vein necrosis, chlorotic spots, chlorotic line patterns, mosaic patterns, variegation, mottling, and abnormal leaf shape, curling, and puckering.
- Excessive branching (brooms). Symptoms differ, depending on causal agent, poplar species, age of tree, season, and host condition. Trees can also be infected but not show any symptoms.

Leaf bronzing of aspen:

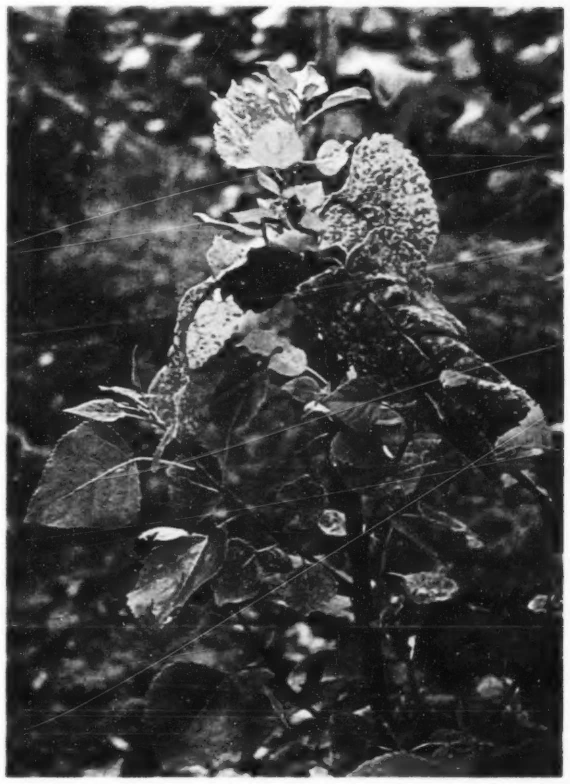
- Leaves yellow in late July and August, then turn bronze and finally dark brown. Leaf petioles on affected branches remain yellow, and there is often a brown discoloration in the wood of the branches.

Virus-infected leaves.

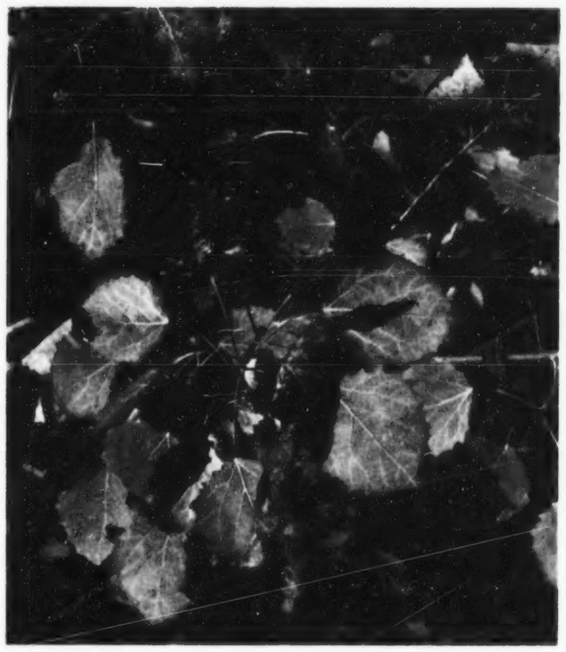
Biology — These pathogens have not been extensively studied in poplars. Additional research is needed to develop reliable methods for detecting and identifying the viruses in poplars. Once infected, a tree will remain infected throughout its life. Viruses can be spread by insect and nematode vectors or by vegetatively propagated planting stock.



Virus-infected leaves.



Leaf puckering.

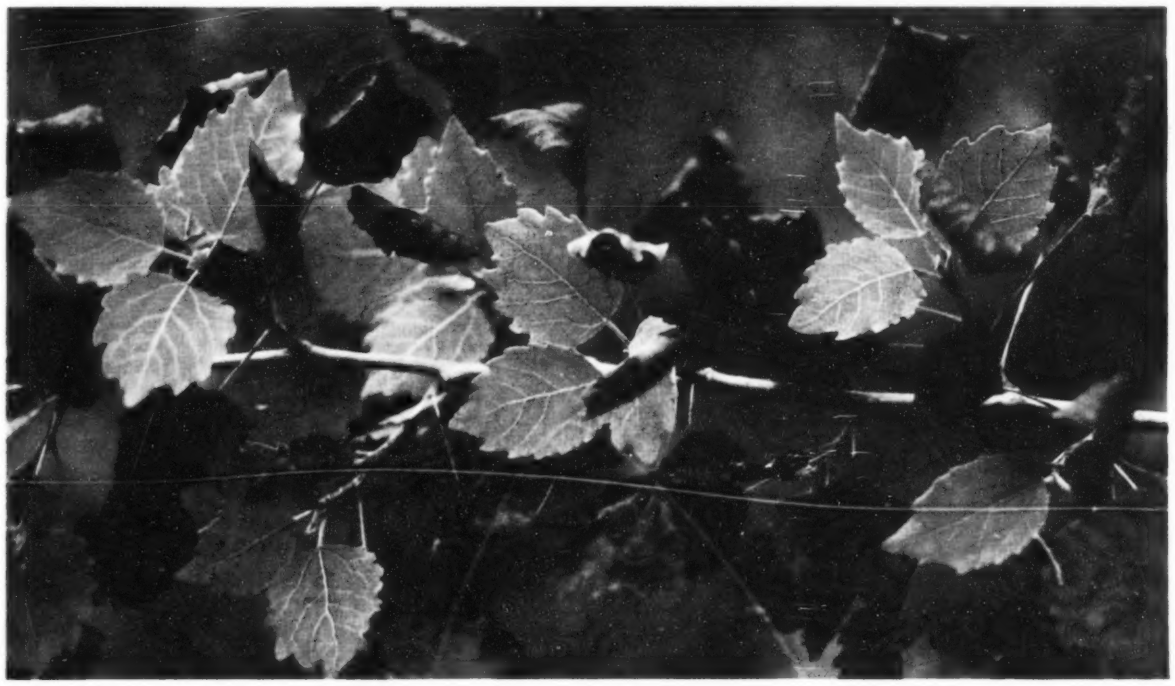


Leaf bronzing.

Monitoring — Suspect a virus or other systemic pathogen when you can't find the cause of a tree's declining vigor. Systemic pathogens should not be a serious problem in trees grown on short rotations except when the stumps and root systems decline in vigor, reducing coppice reproduction.

Control —

- Plant only vigorous, disease-free stock. Cuttings should not be taken from trees obviously stressed or exhibiting symptoms of virus infection.



Leaf bronzing.

- Aseptic culture techniques and heat treatments are available to free poplar clones from known virus infections. These treatments will not guard against virus infections after planting, but will reduce impact on trees grown on short rotations.

At this time there are few direct control measures because we don't fully understand what systemic pathogens are important and we can't detect and identify them efficiently.

For Additional Information—

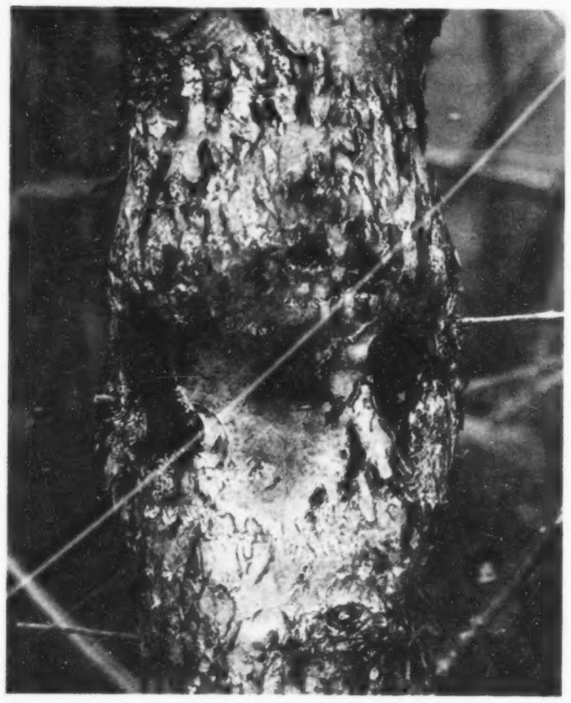
Berbee, J. G.; Omuemu, J. O.; Martin, R. R.; Castello, J. D. 1976. Detection and elimination of viruses in poplars. In: Intensive plantation culture: Five years research. Gen. Tech. Rep. NC-21. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 85–91.

Martin, R. R.; Berbee, J. G.; Omuemu, J. O. 1982. Isolation of a potyvirus from declining clones of Populus. Phytopathology. 72: 1158–1162.

Navratil, S. 1979. Virus and virus-like diseases of poplar: are they threatening diseases? Report 19: Poplar research, management, and utilization in Canada. For. Res. Inf. Pap. 102. Ottawa: Ontario Ministry of Natural Resources; 19: 1–17.

Septoria Canker (*Septoria musiva*)

Importance — Cankers weaken branches and main stems. Multiple cankers girdle trees, causing top dieback, breakage, and tree death. Secondary organisms enter trees through cankers, causing stain and decay. Highly susceptible clones cannot be coppiced because this disease harms new shoots.


Old canker.

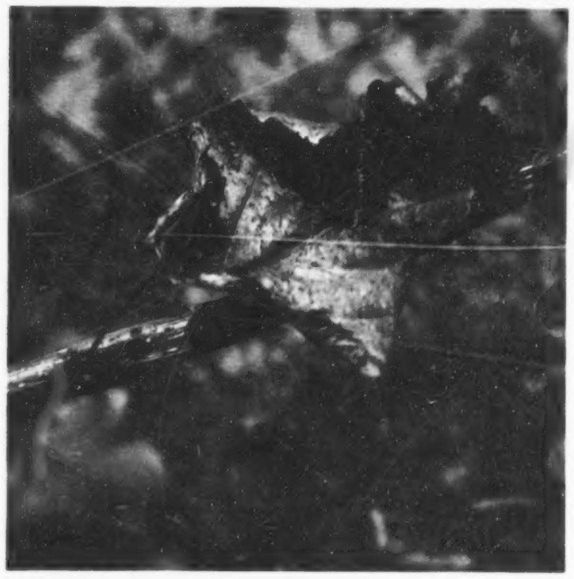
Dieback associated with stem canker.

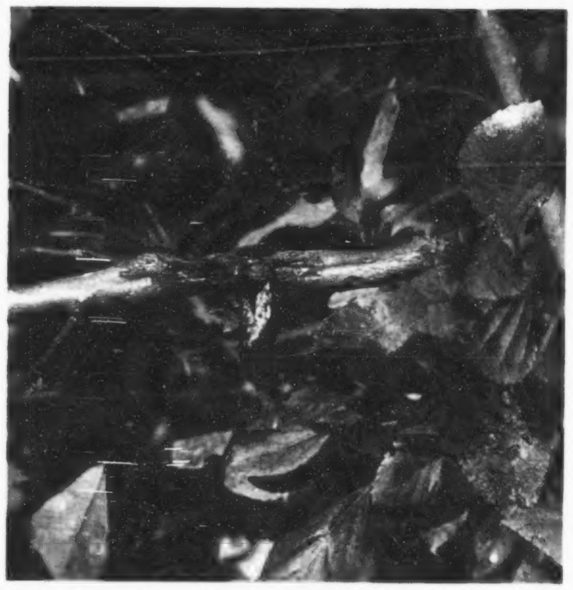
Cankers on stump sprouts.

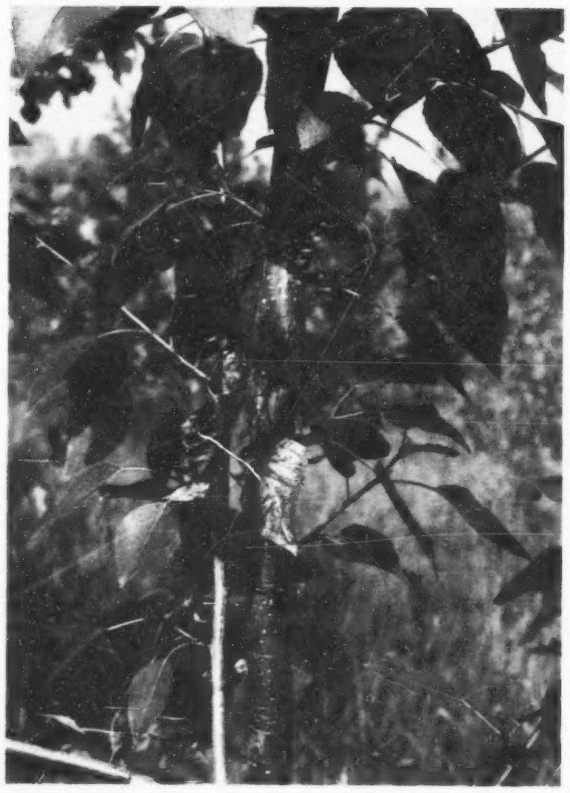
Look For —

- Depressed areas on stems and branches that look water-soaked. Often new cankers have orange or black margins.
- Rough, ash-gray area with a central crack on stem.
- Large, rough cankers on stems and branches. Fruit bodies are usually only found on first-year cankers.

Biology — The fungus overwinters in fallen infected leaves and young cankers. In the spring, ascospores from leaves are windblown and rainsplashed to leaves, stems, and branches, where infection takes place. Secondary infections throughout the summer are caused by conidia, produced in leaf spots, and rainsplashed to adjacent leaves and branches.


Young branch canker.


Branch canker with characteristic malformation of affected area.


Stem canker.

Monitoring — Inspect plantations and nurseries for leaf spots and cankers beginning in midsummer. Trees of all ages are affected. New cankers are more numerous on the younger portions of trees.

Water-soaked appearance of stem canker.

Control —

- Remove infected leaf debris before spore release in the spring to reduce inoculum within plantings and minimize new infections if there are no other nearby sources of inoculum.
- Plant only resistant clones.
- Plant only disease-free nursery stock.
- Harvest highly susceptible clones early and replace them with resistant clones.

For Additional Information —

McNabb, H. S., Jr.; Ostry, M. E.; Sonnelitter, R. S.; Gerstenberger, P. E. 1982. The effect and possible integrated management of *Septoria musiva* in intensive short-rotation culture of *Populus* in the north central states. In: Zavitkovski, Jerry; Hansen, Edward A., eds. Proceedings, North American poplar council meeting; 1982 July 20–22; Rhinelander, WI. Manhattan, KS: Kansas State University: 51–58.

Moore, Lincoln M.; Ostry, Michael E.; Wilson, Louis F.; Morin, Michael J.; McNabb, Harold S., Jr. 1982. Impact of Septoria canker caused by *S. musiva* on nursery stock and first-year plantation coppice. In: Zavitkovski, Jerry; Hansen, Edward A., eds. Proceedings, North American poplar council meeting; 1982 July 20–22; Rhinelander, WI. Manhattan, KS: Kansas State University: 44–50.

Ostry, M. E. 1987. Biology of *Septoria musiva* and *Marssonina brunnea* in hybrid *Populus* plantations and control of Septoria canker in nurseries. European Journal of Forest Pathology. 17: 158–165.

Ostry, M. E.; McNabb, H. S., Jr. 1983. Diseases of intensively cultured hybrid poplars: a summary of recent research in the north central region. In: Hansen, Edward A., comp. Intensive plantation culture: 12 years research. Gen. Tech. Rep. NC-91. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 102–109.

Ostry, Michael E.; McNabb, Harold S., Jr. 1986. *Populus* species and hybrid clones resistant to *Melampsora, Marssonina,* and *Septoria.* Res. Pap. NC-272. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 7 p.

Ostry, M. E.; McNabb, H. S., Jr. 1985. Susceptibility of *Populus* species and hybrids to disease in the north central United States. Plant Disease. 69: 755–757.

Palmer, Marguerita A.; Schipper, Arthur L.; Ostry, Michael E. 1980. How to identify and control Septoria leaf spot and canker of poplar. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 6 p.

Thompson, G. E. 1941. Leaf spot diseases of poplars caused by *Septoria musiva* and *S. populicola.* Phytopathology. 31: 241–254.

Hypoxylon Canker (*Hypoxylon mammatum*)

Importance — *Hypoxylon* girdles and kills stems and branches. Small trees can be killed in as little as 2 to 4 years. Stain and decay fungi enter trees through cankers, weakening trees so that they break in wind.

Look For —

- Young cankers that are slightly sunken, yellowish-orange areas on the bark of stems and branches, often associated with various insect wounds.
- Blistered bark of older cankers with gray hyphal pegs with asexual spores (conidia) under the bark.
- Advanced cankers with sexual spores (ascospores) in raised gray-black structures resembling cushions on the cankered stem surface.

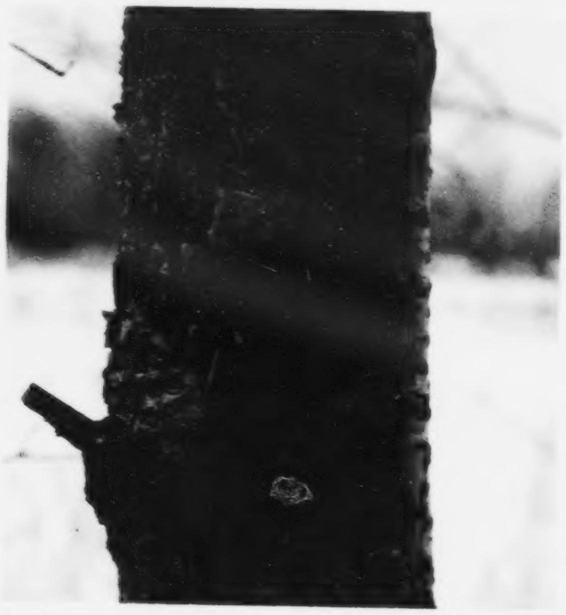
Young canker associated with insect gall.

Biology — The fungus overwinters on cankered trees. Dead trees remain an inoculum source for several years. Ascospores from 3-year-old or older cankers presumably infect trees through various kinds of wounds or breaks in the bark near branches.

Monitoring — Examine trees for canker. Harvest seriously affected stands early to minimize losses. Oviposition wounds made by several species of insects can be colonized by *Hypoxylon,* so trees that have many of these wounds should be considered at risk.

Control —

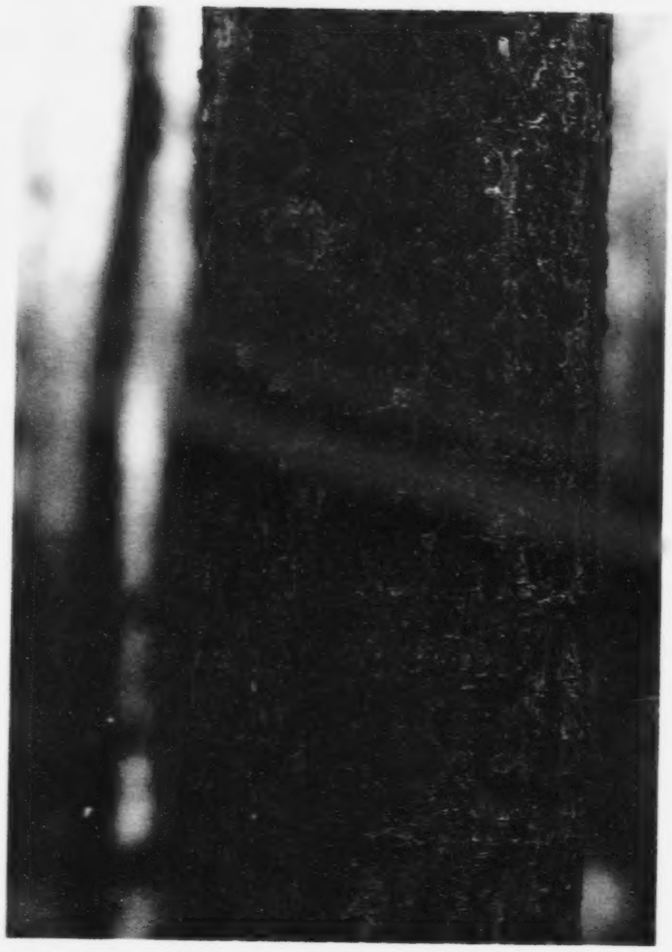
- No direct control measures are known. However, branch cankers, if detected early, can be removed by pruning to pre-



Blistered bark of older canker.

vent the fungus from growing into the main stem.

- *Hypoxylon* is primarily a pathogen of the aspens, although occasionally certain hybrid poplars are also infected. Poplars in the Section Leuce (white poplars) should not be planted where *Hypoxylon* is known to be a problem.
- Maintain well-stocked stands. Thin stands and open-grown trees are favored by insects that can cause wounds through which *Hypoxylon* can enter.



Fruit bodies on old canker.

For Additional Information —

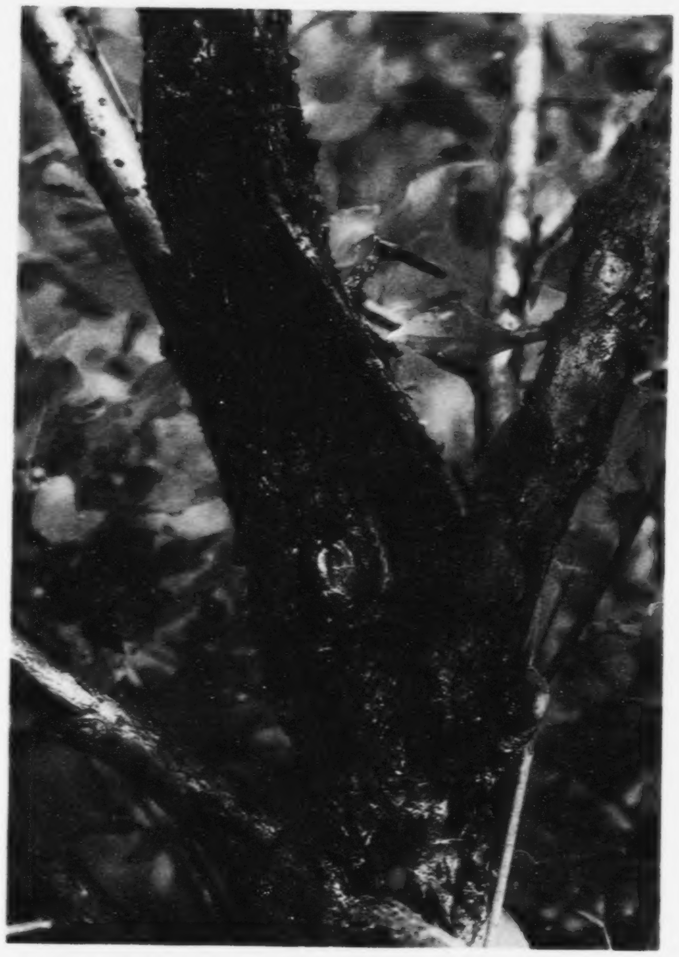
Anderson, R. L.; Anderson, G. W. 1979. Hypoxylon canker of aspen. For. Insect & Dis. Leafl. 6. Washington, DC: U.S. Department of Agriculture, Forest Service. 7 p.

Anderson, G. W.; Martin, M. P. 1981. Factors related to incidence of Hypoxylon cankers in aspen and survival of cankered trees. Forest Science. 27: 461–476.

Anderson, N. A.; Ostry, M. E.; Anderson, G. W. 1979. Insect wounds as infection sites for *Hypoxylon mammatum* on trembling aspen. Phytopathology. 69: 476–479.

Ostry, M. E.; Anderson, N. A. 1983. Infection of trembling aspen by *Hypoxylon mammatum* through cicada oviposition wounds. Phytopathology. 73: 1092–1096.

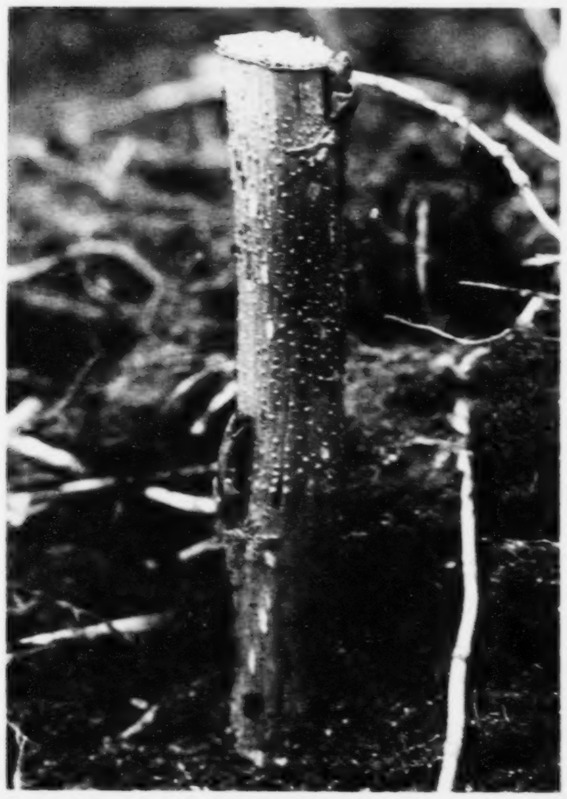
Schipper, A. L.; Anderson, R. L. 1976. How to identify Hypoxylon canker of aspen. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 6 p.



Advanced decay of affected stem.

Bark Necrosis, Dieback, "Blackstem" (*Cytospora, Phomopsis, Dothichiza*)

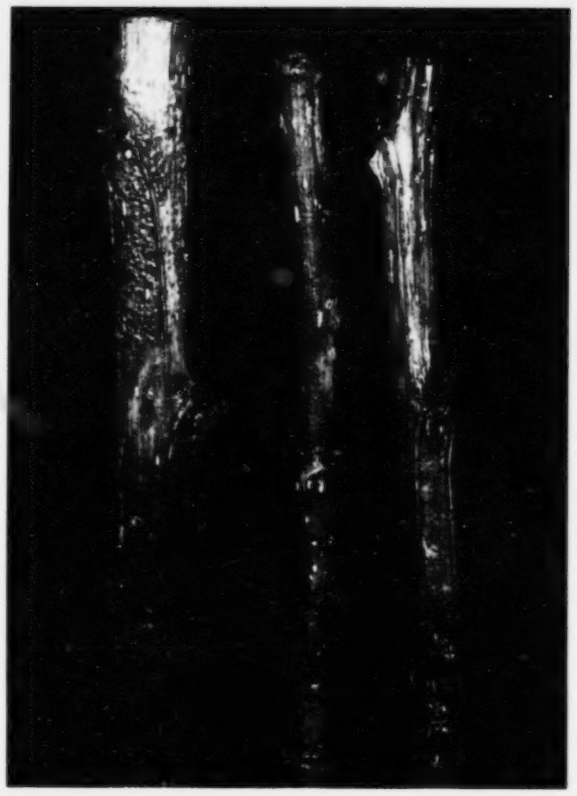
Importance — These fungi cause dieback, bark necrosis, and cankers on branches and main stems of native and introduced poplars. Unrooted hardwood cuttings can be damaged during storage or killed shortly after planting by *Cytospora* and *Phomopsis*.

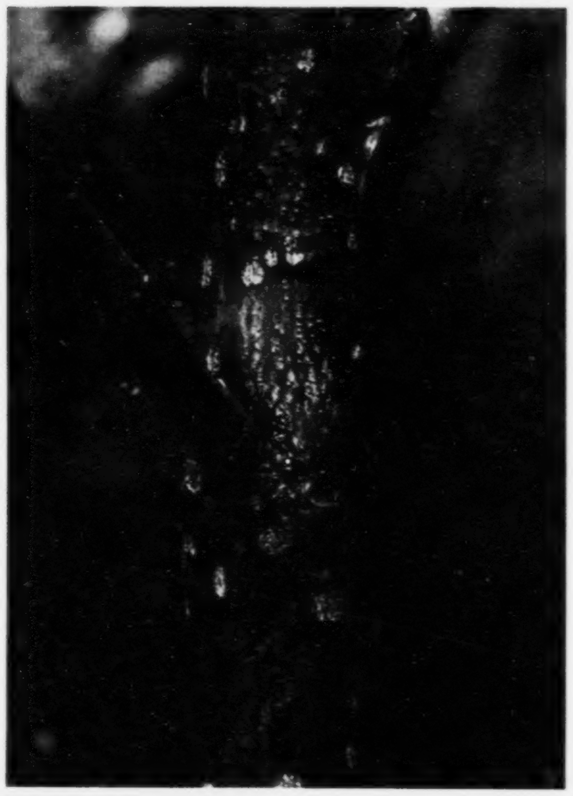

Damaged cutting in field.

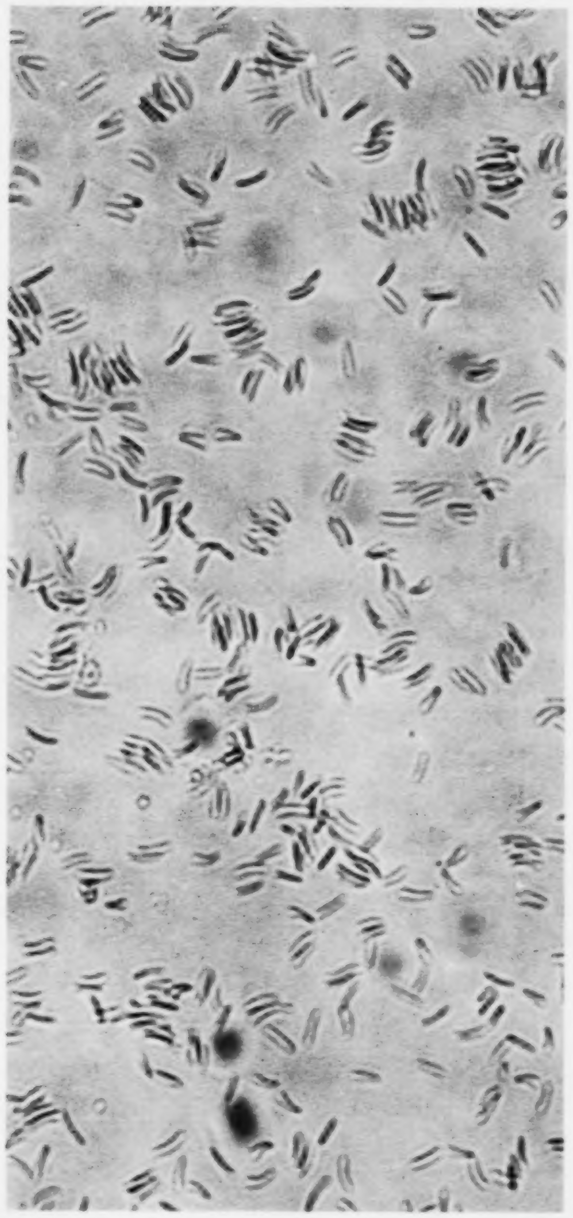
Look For —

- Slightly sunken cankers with definite margins or discolored patches of bark on branches or main stems. Infected tissues may be yellow, orange, brown, or black, in contrast to the green healthy bark.
- Raised, pimple-like fruit bodies (pycnidia) in infected bark.
- White, yellow, or orange tendrils (spore horns) of conidia exuding from pycnidia during moist weather. When dry, tendrils appear as fine white, yellow, or orange hairs.

Symptoms produced by these fungi look alike, so examine spores or obtain a culture from diseased tissues to positively identify the causal organism.


Cuttings affected by "blackstem" in storage.


Cytospora *sporulating.*

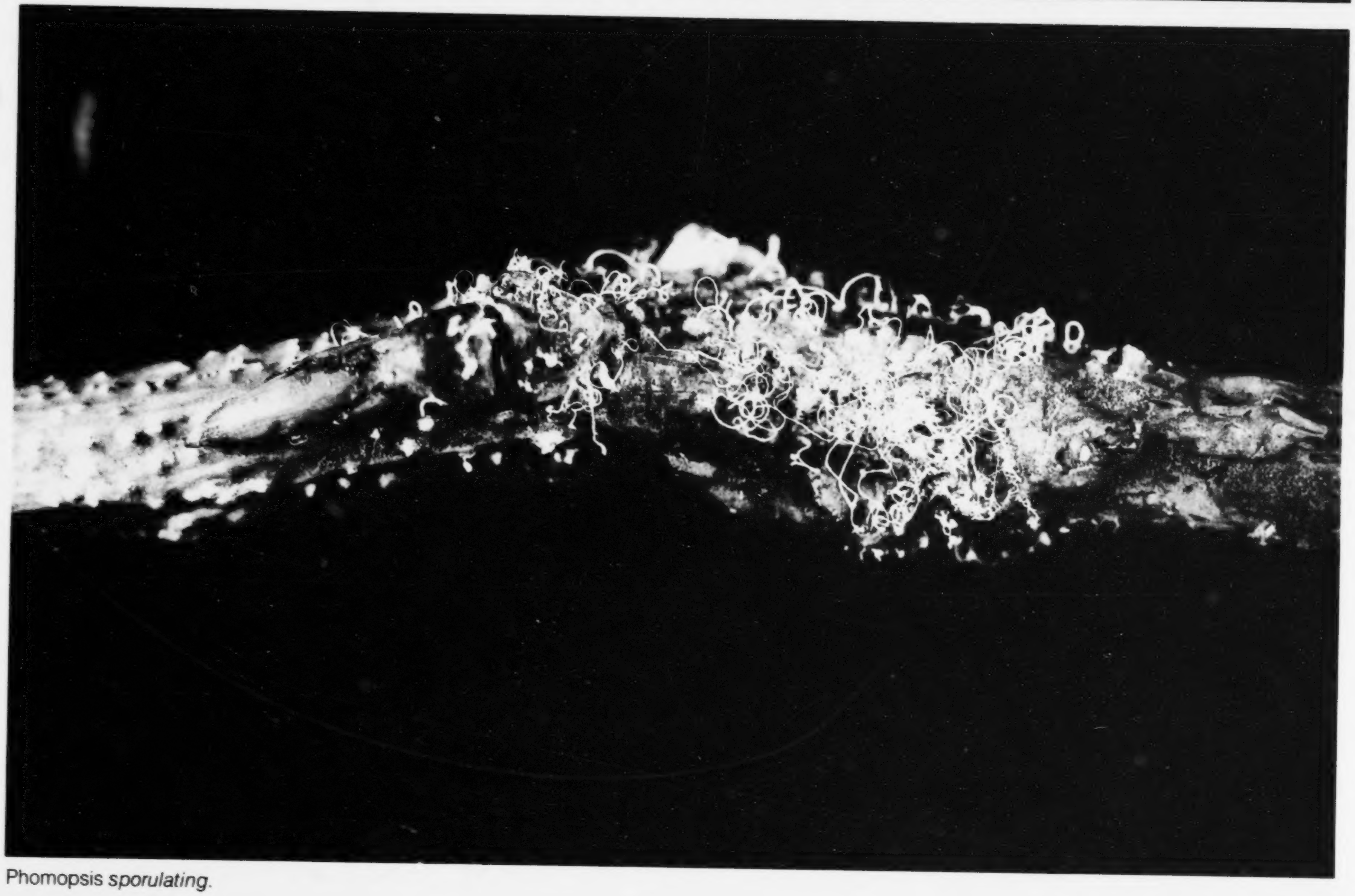

Conidia of Cytospora.

Biology — These fungi are common on dead and dying poplars. However, they can also infect live trees of low vigor and injured tissues. Trees under stress from drought, insect attack, frost, sunscald, nutrient imbalance, or other diseases are particularly vulnerable to infection. Loss of internal bark moisture favors disease development. Rainsplashed spores (conidia) infect the tree through bud scales, leaf scars, and wounded or stressed bark. In addition to conidia of *Cytospora* and *Dothichiza,* windblown ascospores are also presumably involved. Infected twigs and small branches are quickly girdled. Elongated cankers and patches of dead bark develop on stems as the bark and sapwood are progressively invaded. Cultural practices that increase host vigor inhibit further bark infection.

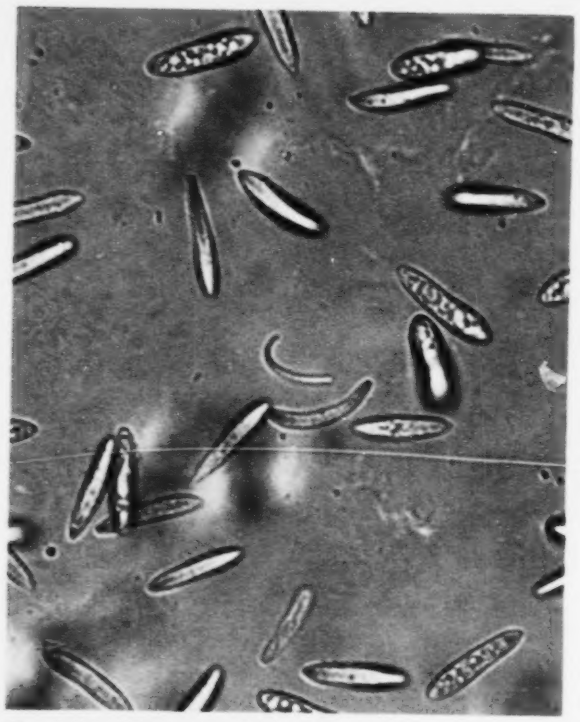
Monitoring — Examine trees for factors that predispose them to infection by these fungi. Closely examine seedlings and hardwood cuttings for symptoms before planting.

Control —

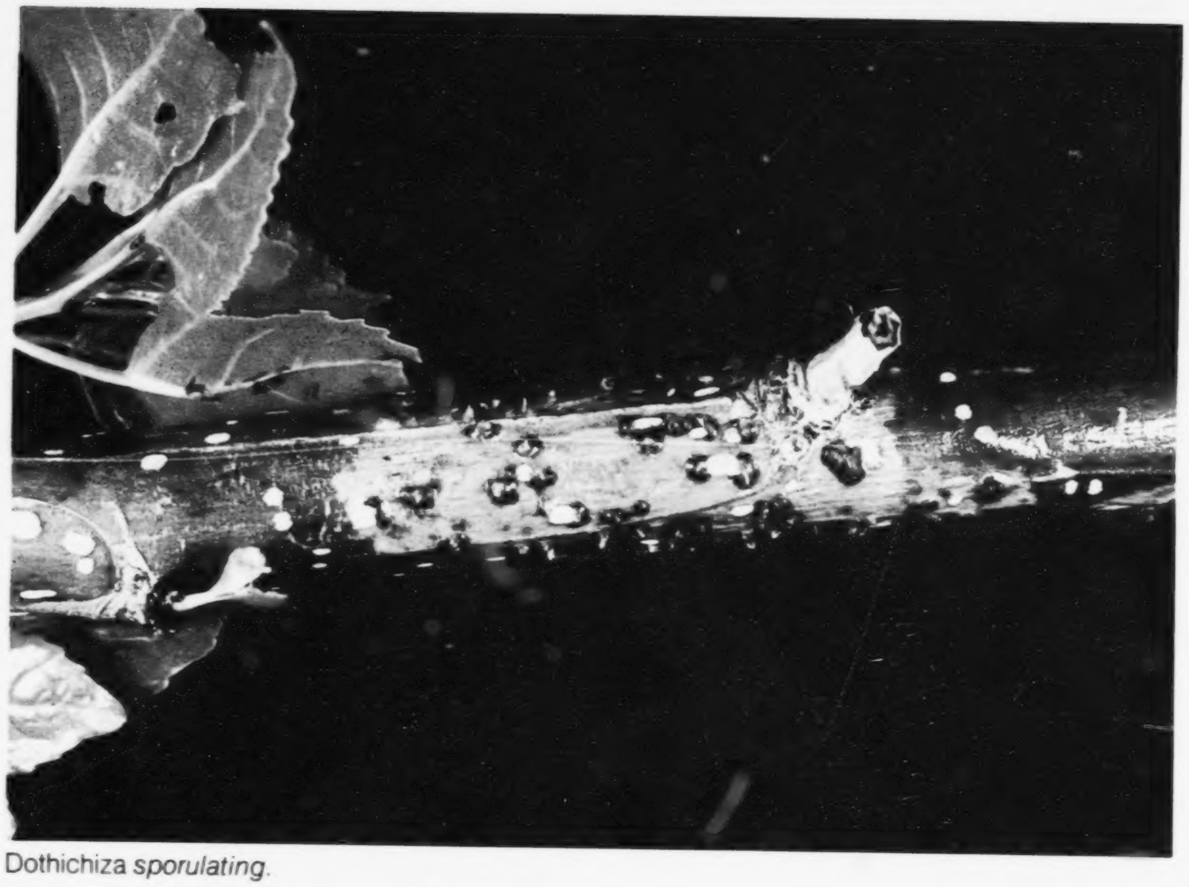
- Plant cuttings and seedlings during periods of favorable moisture and temperature to minimize stress.



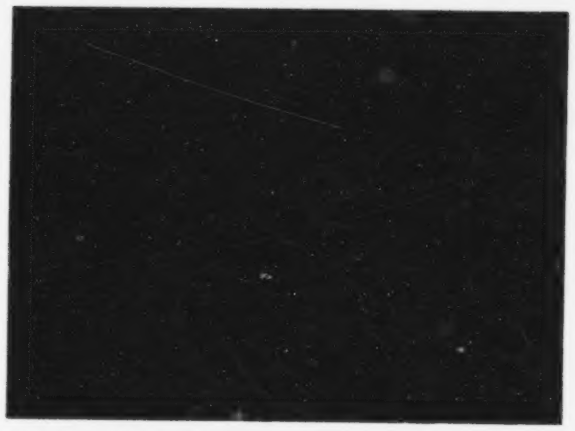
Phomopsis *sporulating.*



Conidia of Phomopsis.



Dothichiza *sporulating.*



Conidia of Dothichiza.

- Plant clones resistant to premature defoliation by *Melampsora* or *Marssonina* that can reduce tree vigor.
- Plant only on sites suitable for good poplar growth.
- Control weeds, irrigate, and fertilize trees to maintain good growth.
- Plant trees far enough apart to minimize competition among them for available moisture, light, and nutrients.
- Avoid wounding trees.
- Prevent sunscald by wrapping tree trunks with Kraft paper to reduce injury to bark tissues.
- Protect cuttings or rooted stock from drying out or becoming heated during processing, storage, shipping, and planting. Maintain storage temperature at approximately 26°F.
- Collect cuttings only from disease-free, vigorously growing stock.

For Additional Information —

Haywood, William F.; McNabb, Harold S., Jr. 1979. Moisture stress and incidence of stem cankers in intensively grown poplars. In: Proceedings, 1st North central tree improvement conference; 1979 August 21-23; Madison, WI: 123-132.

Ostry, Michael E.; McNabb, Harold S., Jr. 1980. How to identify and prevent injury to poplars caused by Cytospora, Phomopsis, and Dothichiza. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 7 p.

Ostry, M. E.; McNabb, H. S., Jr. 1982. Preventing blackstem damage to *Populus* hardwood cuttings. In: Zavitkovski, Jerry; Hansen, Edward A., eds. Proceedings, North American poplar council meeting; 1982 July 20-22; Rhinelander, WI. Manhattan, KS: Kansas State University: 36-43.

Tao, Dali; Li, Paul H.; Carter, John V.; Ostry, Michael E. 1984. Relationship of environmental stress and Cytospora chrysosperma infection to spring dieback of poplar shoots. Forest Science. 30: 645-651.

Walla, J. A.; Stack, R. W. 1980. Dip treatment for control of blackstem on *Populus* cuttings. Plant Disease. 64: 1092-1095.

Miscellaneous Cankers (*Fusarium, Nectria, Ceratocystis, Cryptosphaeria, Phibalis* (= *Cenangium,* = *Encoelia)*

Importance — Cankers are among the most common and serious diseases of poplars. In addition to killing trees directly, they serve as entrance points for stain and decay fungi that further reduce tree quality and subject affected trees to wind breakage.

Look For —

- Bark discoloration and sunken areas on the bark.
- Irregular breaks in the bark.
- Target-shaped rings of dead bark.
- Blackened inner bark.
- Swollen, misshapen areas of stems.

Many cankers look alike, making diagnosis difficult unless fruit bodies are present or the causal agents are isolated.

Biology — Generally, canker fungi enter trees through various wounds. Presumably spores are involved, but the exact conditions favoring infection for the different fungi are not well understood. Cankers can be grouped into three categories: annual, perennial, and diffuse, depending upon their particular host-pathogen interactions. *Fusarium* causes an annual canker be-

Fusarium *(annual canker).*

Nectria *(perennial canker).*

cause the fungus is stopped by callus growth after the first year. In contrast, *Ceratocystis* and *Nectria* cause perennial cankers where the fungus escapes the callus layer produced by the tree each year, resulting in target-shaped cankers. Trees infected by fungi like *Phibalis* and *Cryptosphaeria* usually can't wall off the fungus with callus, and large, diffuse cankers result.

Control—

- No direct control measures are known.
- Avoid wounding trees.
- Harvest trees before cankers reduce quality or yield potential.

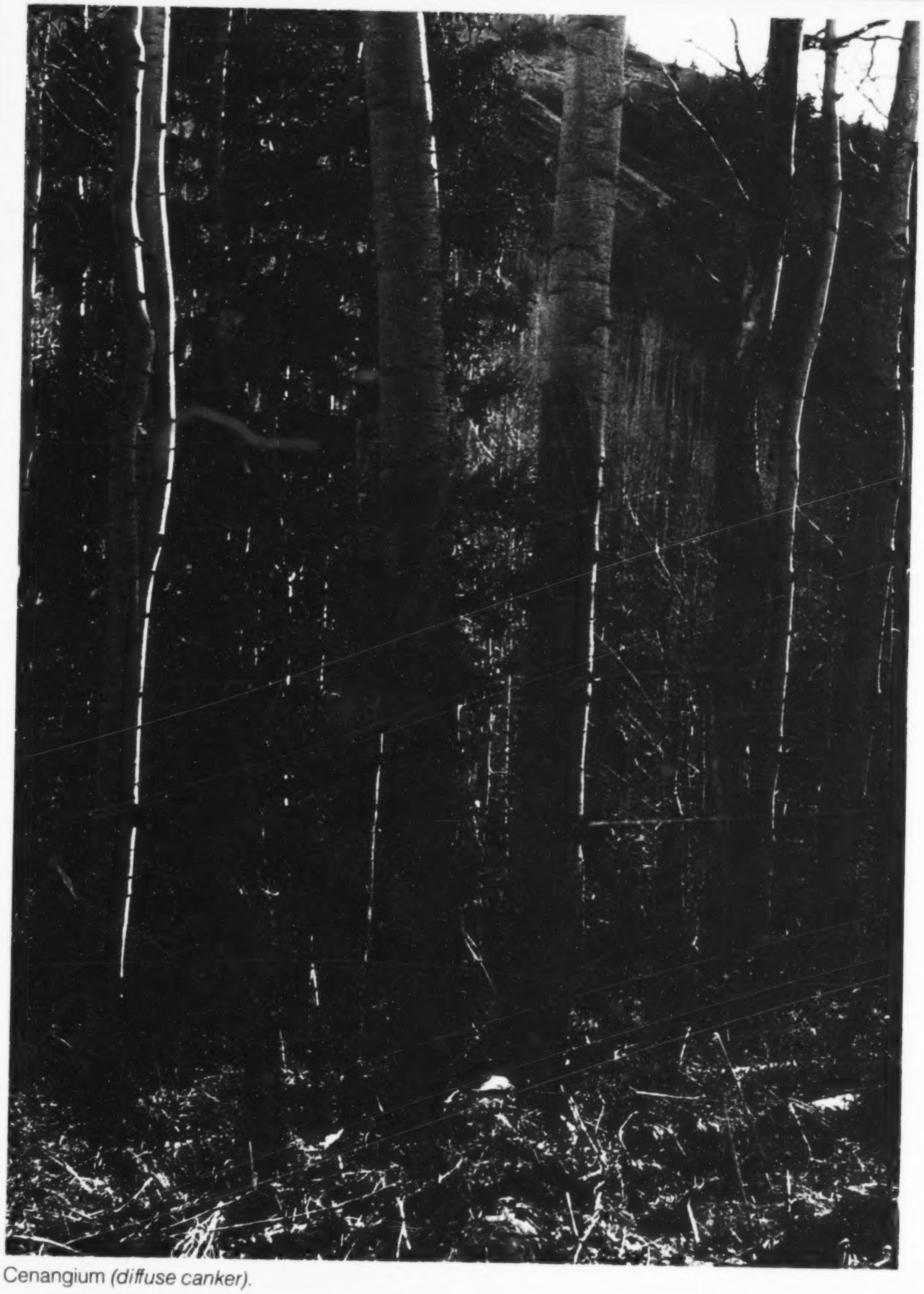
For Additional Information—

Dochinger, Leon S. 1967. Occurrence of poplar cankers caused by *Fusarium solani* in Iowa. Plant Disease Reporter. 11: 900–903.

Hinds, T. E. 1972. Ceratocystis canker of aspen. Phytopathology. 62: 213–220.

Hinds, T. E. 1981. Cryptosphaeria canker and Libertella decay of aspen. Phytopathology. 71: 1137–1145.

Manion, Paul D.; French, D. W. 1967. *Nectria galligena* and *Ceratocystis fimbriata* cankers of aspen in Minnesota. Forest Science. 13: 23–28.



Cenangium *(diffuse canker).*

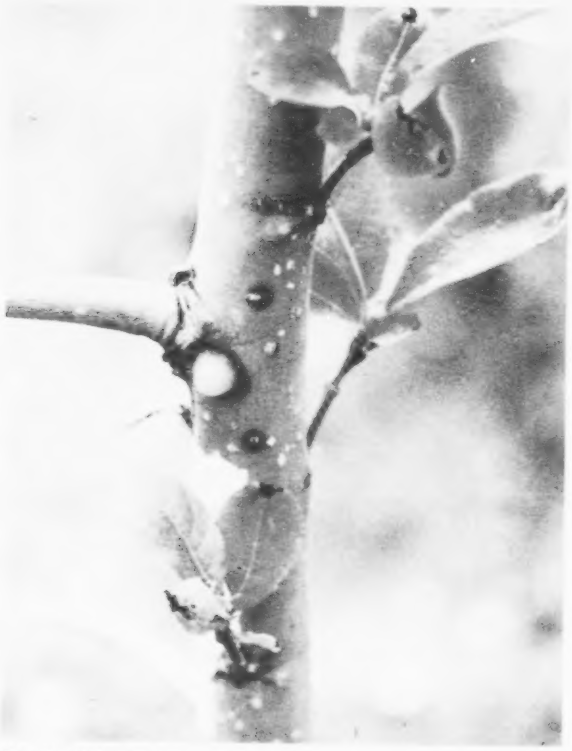
Bacterial Canker and Dieback (*Xanthomonas populi*)

Importance — Bacterial Canker is an extremely serious branch and stem disease of all species of *Populus*. It is now found only in northern France, Belgium, the Netherlands, the Federal Republic of Germany, the United Kingdom, Ireland, and Denmark. Selection and breeding programs have produced many resistant clones.

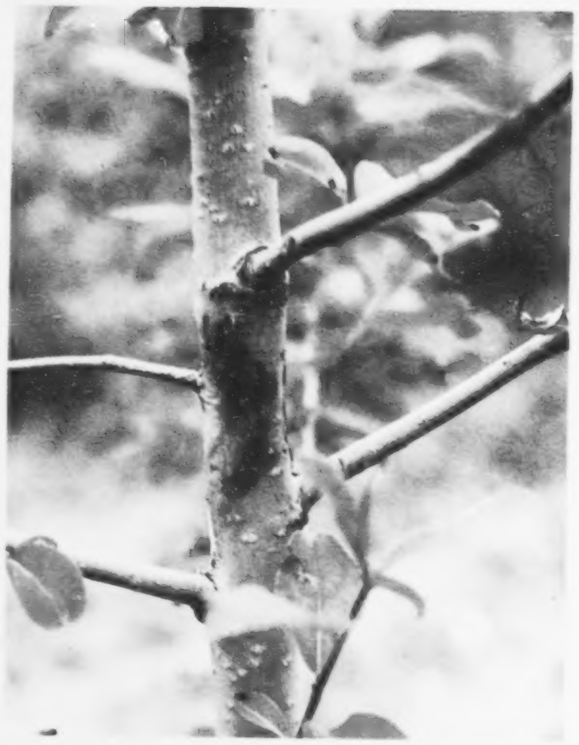
Look For —

- On branches or small stems, blisters that become black, cracked, sunken areas of bark that may have cream to white bacterial ooze during cool, moist periods.
- Leaves on small shoots or on small stems near cankers may have blackened necrotic areas and later die.
- Small stems may break at canker area.
- Dead branches in larger trees.
- Trunk deformities looking like cankers, irregular galls, or severely roughened bark on larger trees.

Biology — Bacterium can spread by wind-blown water droplets, tools, insects, and animals. Infection is through leaf scars and fresh wounds on branches and stems. The extent of bark and stem symptoms depends on the tree's susceptibility to the disease.



Bacterial ooze.



Young canker and blackened bark of affected stem.

Old canker and rough bark of affected stem.

Monitoring — Careful monitoring for this disease is essential in North America to detect it early and eradicate it. Examine young trees for bacterial ooze on blister-like or blackened areas on branches or main stems near shoot bases and blackened leaves on such shoots. Any stem breakage should be closely examined for such symptoms. Carefully monitor poplars from the *Tacamahaca* section because they may be especially susceptible. Willow is also susceptible to this bacterial disease and should be included in any monitoring program where both poplars and willows are being grown.

Control —

- Planting highly resistant clones from selection and breeding programs — the only way to control this disease.

Root and Butt Rot

Armillaria Root and Butt Rot (*Armillaria mellea*)

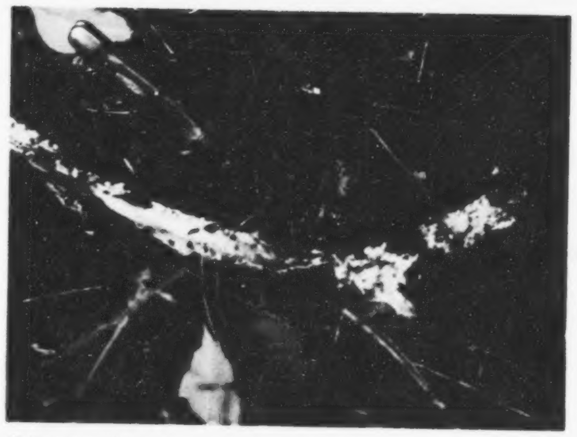
Importance — *Armillaria* causes a root and butt rot of poplars. This root disease may be more damaging under intensive management systems than in natural stands. Repeated harvests and vegetative reproduction from stumps may increase disease incidence and severity.

Look For —

- White mycelium under the bark of infected trees.
- Strands of dark brown to black fungus mycelium (rhizomorphs) resembling shoestrings, around infected roots, under the bark of infected trees, or in decayed wood.
- Honey-colored, gilled mushrooms at the base of infected trees for a few weeks in early fall. These mushrooms will then turn black and shrivel, persisting for several months.

Biology — *Armillaria* overwinters as rhizomorphs or vegetative mycelium in infected live and dead trees. Armillaria root rot is usually associated with weakened trees. The fungus can spread from one tree to another by rhizomorphs that grow through the soil until they contact and infect a root of another tree. Mycelium of the fungus then spreads through the root system of that tree, causing root rot and eventually butt rot.

Butt rot.

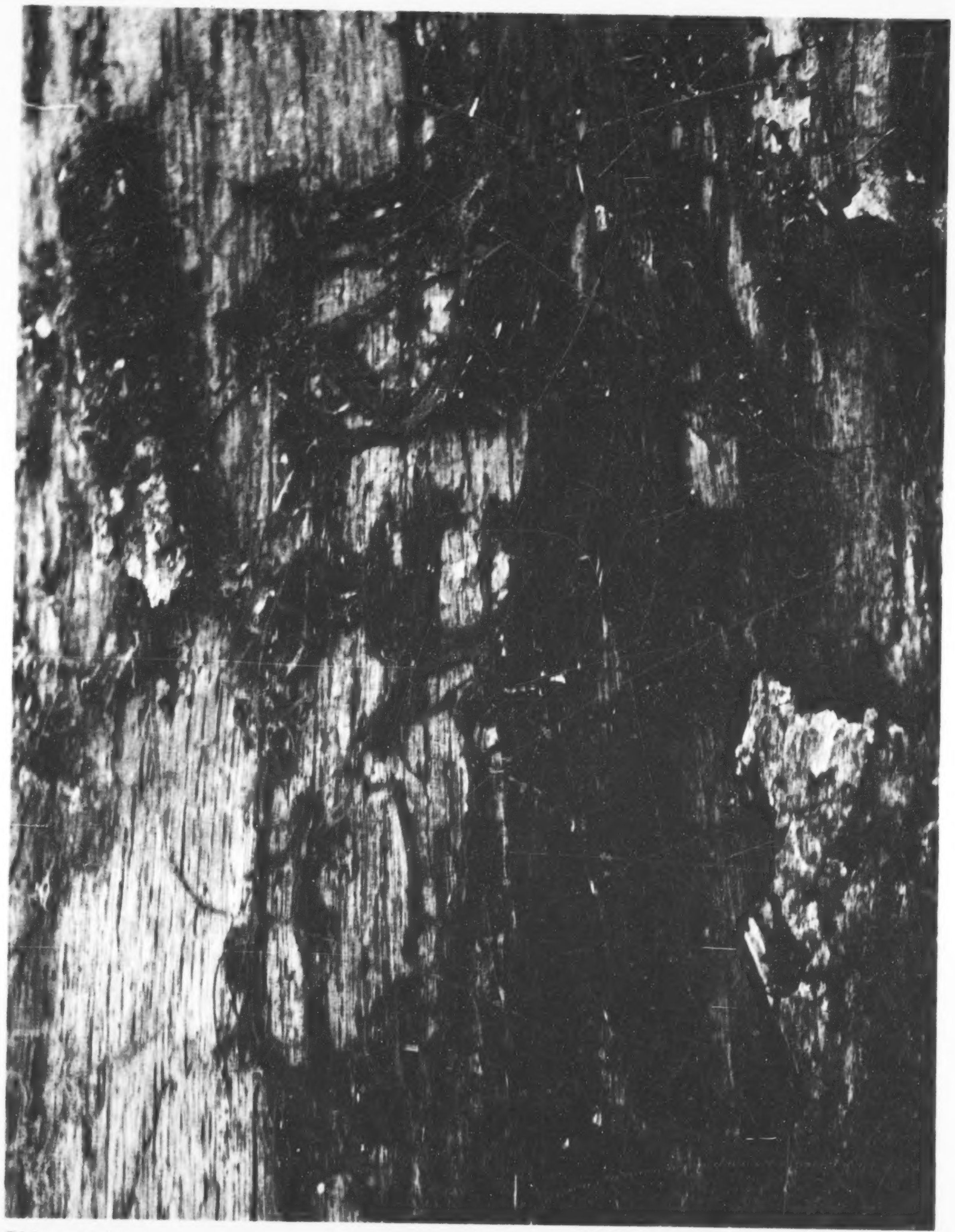


Diseased root.

Monitoring — Examine dead and dying trees or stumps for *Armillaria*. This is especially important in nursery stool beds and coppiced plantations.

Control —

- Maintain high tree vigor by minimizing tree stress caused by other biotic agents as well as noninfectious diseases.
- Minimize the number of infected live and dead trees in new plantings by removing as much of the old root system as possible to reduce inoculum in the soil.



Rhizomorphs.

Septoria Leaf Spot (*Septoria musiva*)

Importance — Severe leaf infection may reduce growth potential by decreasing leaf photosynthetic area. Premature defoliation of highly susceptible trees is common. Spores produced in leaf spots can cause cankers on susceptible clones (see Canker Diseases).

Look For —

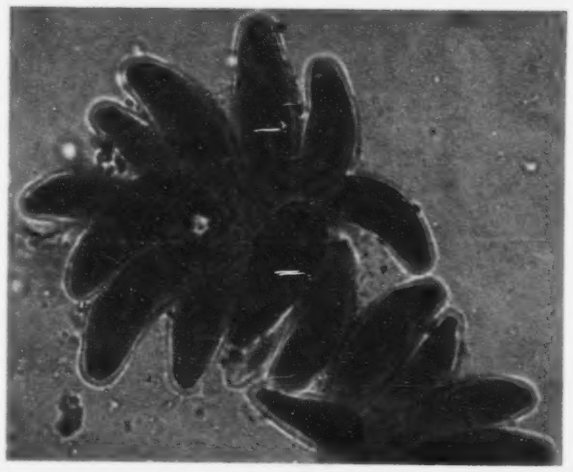
- Circular leaf spots up to one-half inch in diameter with brown or yellow margins. Black fruit bodies (pycnidia) are often present within spots.
- Irregular-shaped large spots with dark margins and tan centers. The spots may be target-shaped with pycnidia clustered in the centers.
- Small, angular leaf spots that often coalesce to form large spots.
- White, silvery spots, one-eighth inch in diameter.

Biology — The fungus overwinters in infected, fallen leaves and in young stem cankers. In the spring, sexual spores (ascospores) from fruit bodies (perithecia) in the fallen leaves are released during wet weather. Wind and rainsplash carry these spores to leaves, branches, and stems, where infection takes place. Asexual spores (conidia) develop in these primary infections and are rainsplashed to adjacent leaves and stems, causing secondary infections.

Monitoring — Examine trees for leaf spots in early summer and new cankers in midsummer to late summer. Cankers are most visible after leaf fall.

Control —

- Plant only uninfected nursery stock because this fungus can become established early in plantings if infected stock is planted.
- Harvest highly susceptible trees early and replant with resistant clones.

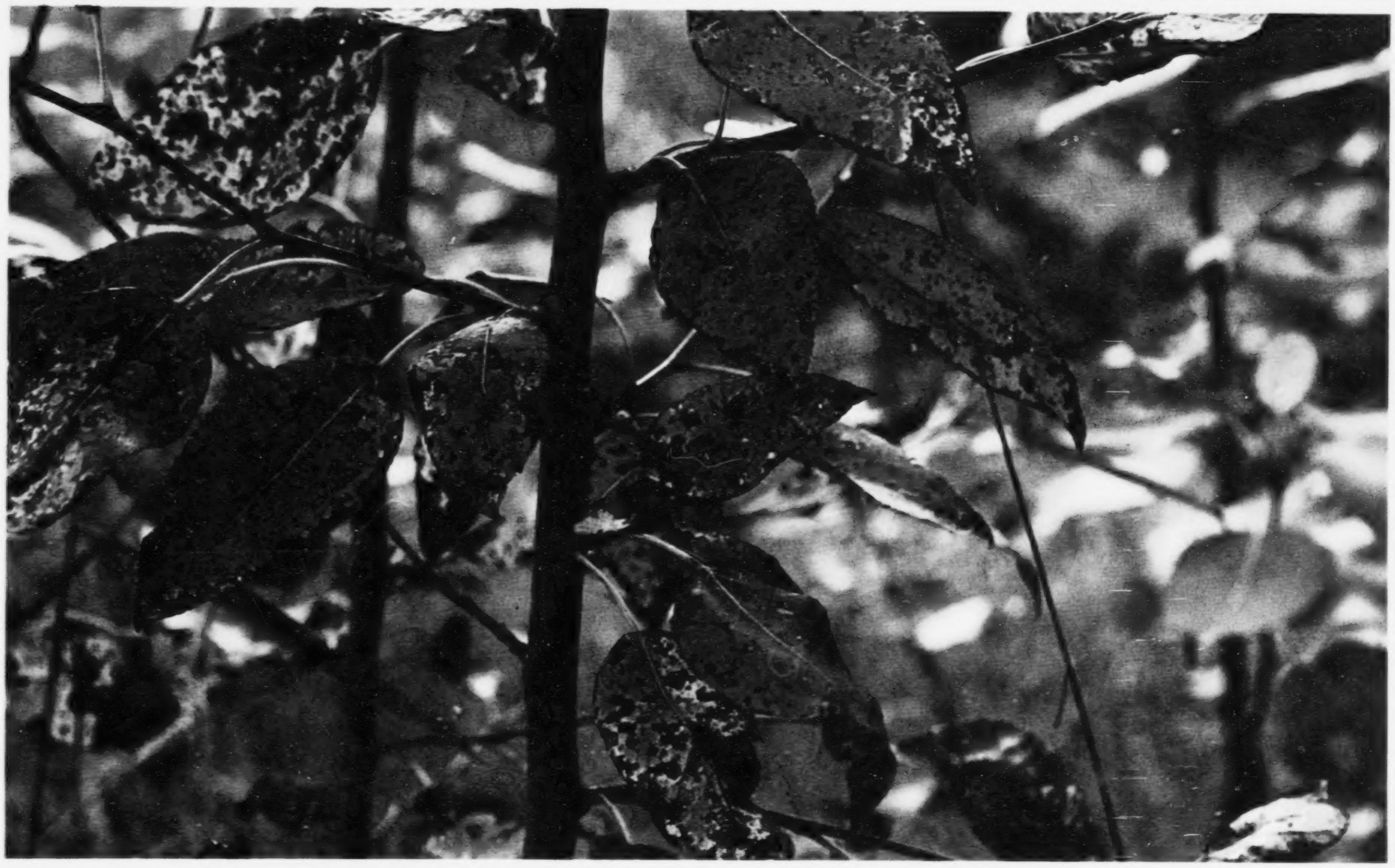


Ascospores in asci (sac-like cells).

Susceptibility to *Septoria* differs by clone. Plant only resistant clones. Generally, *P.* X *euramericana* clones are more resistant than clones with *P. trichocarpa* as a parent.

For Additional Information —

Ostry, M. E. 1987. Biology of *Septoria musiva* and *Marssonina brunnea* in hybrid



Leaf spot.

Conidia.

Populus plantations and control of Septoria canker in nurseries. European Journal of Forest Pathology. 17: 158–165.

Ostry, Michael E.; McNabb, Harold S., Jr. 1986. *Populus* species and hybrid clones resistant to *Melampsora*, *Marssonina*, and *Septoria*. Res. Pap. NC-272. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 7 p.

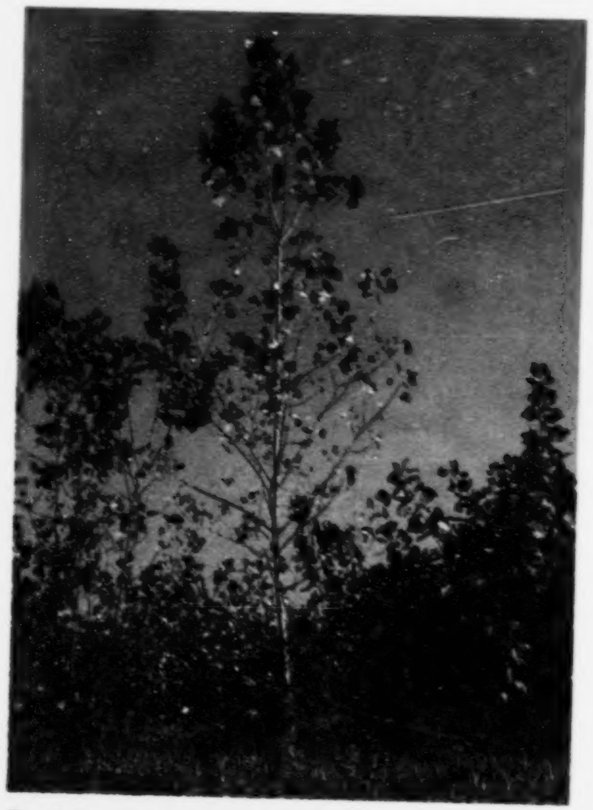
Ostry, M. E.; McNabb, H. S., Jr. 1985. Susceptibility of *Populus* species and hybrids to disease in the north central United States. Plant Disease. 69: 755–757.

Palmer, Marguerita A.; Schipper, Arthur L.; Ostry, Michael E. 1980. How to identify and control Septoria leaf spot and canker of poplar. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 6 p.

Partially defoliated tree (left) compared to resistant tree.

Leaf Rust (*Melampsora medusae, M. occidentalis, M. abietis-canadensis*)

Importance — Species of Melampsora are found throughout North America. Infection by *Melampsora* spp. can cause premature defoliation and reduce growth potential by more than 20 percent. Trees defoliated early in the growing season are more susceptible to other diseases and to environmental stresses.



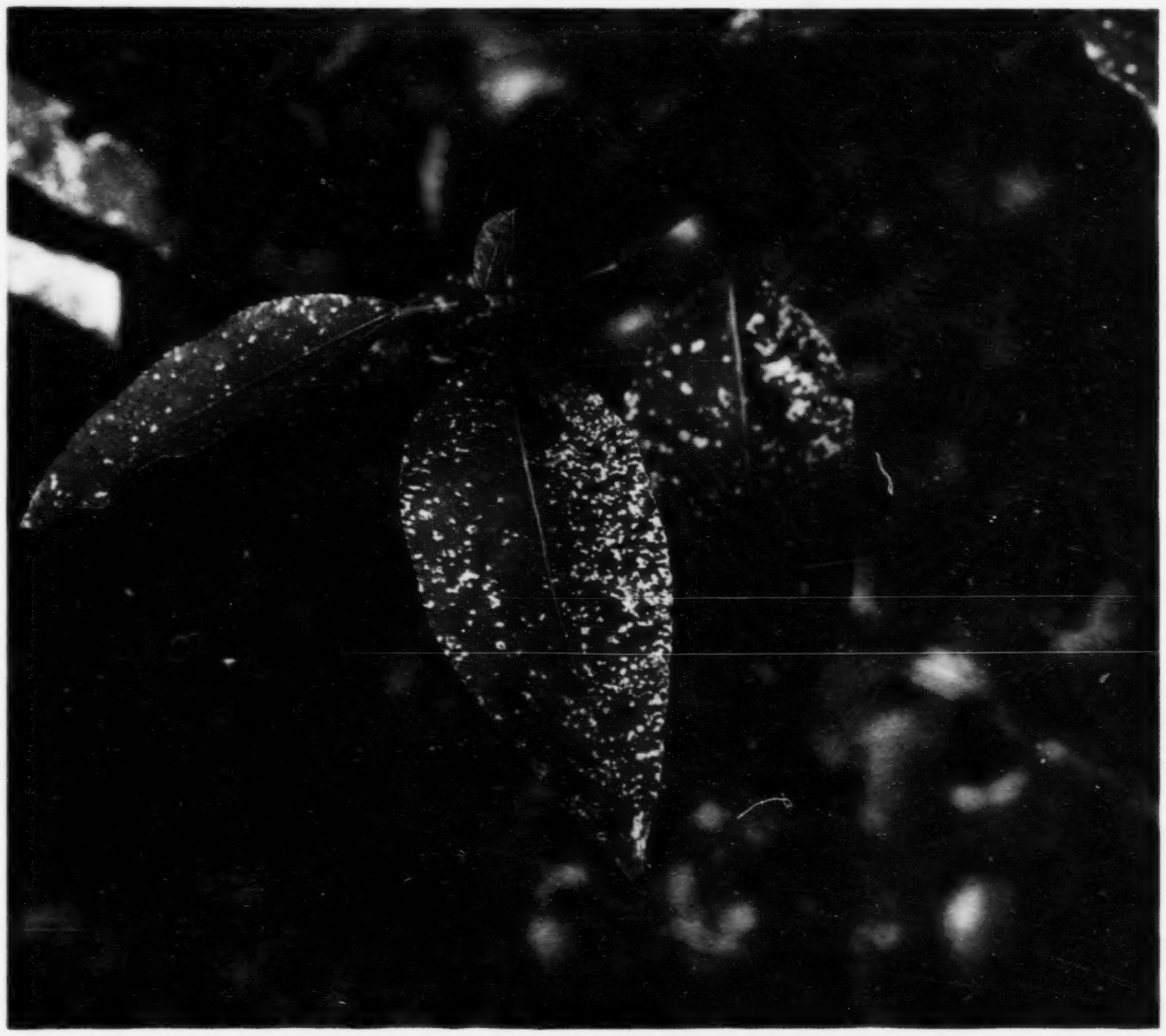
Partially defoliated tree.

Look For —

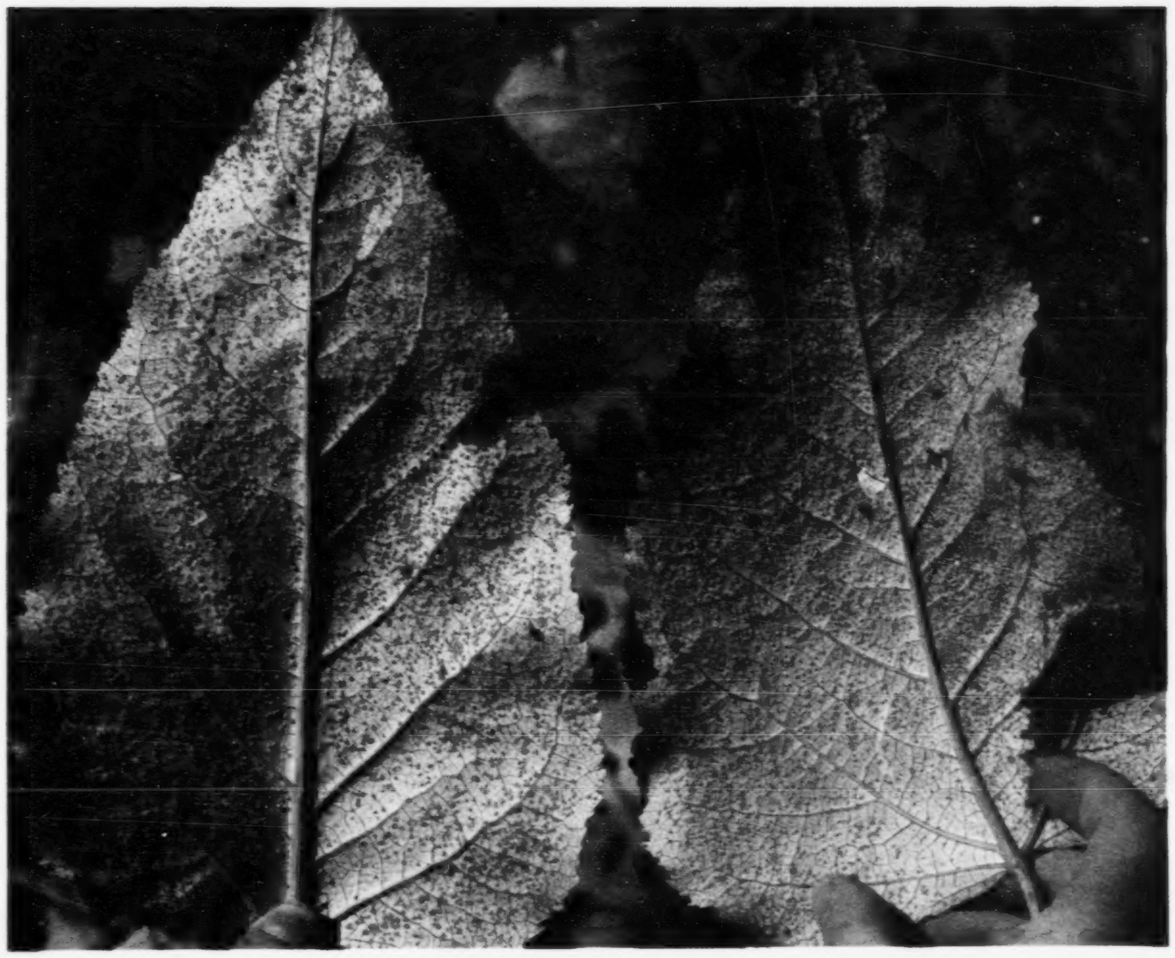
- Yellow to orange pustules (uredia) on the undersides of leaves in mid to late summer. Uredia may be present in early summer where the alternate host exists.

Biology — *Melampsora spp.* require two hosts to complete their life cycle — poplar and a coniferous alternate host. The species of the alternate host depends upon the *Melampsora* species present.

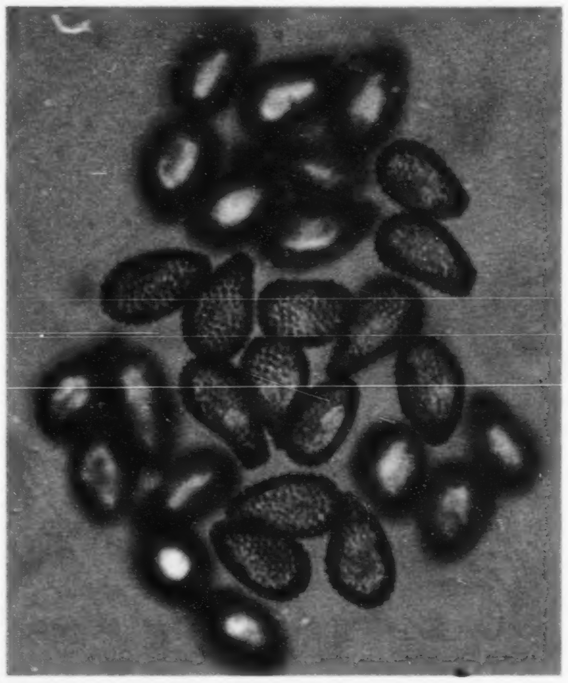
In the spring during wet weather, spores from fallen infected poplar leaves travel by wind to developing pine, larch, or hemlock needles and infect them. In early summer, another spore type (aeciospore) is produced on the conifer host and is windblown to poplar leaves where the yellow uredia pustules develop. The closer poplars are to the conifer alternate host, the earlier in the season they become infected. Urediospores from the uredia pustules are windblown to adjacent poplar leaves, infecting them. The fungus overwinters on fallen poplar leaves.



Leaf spots.



Uredial pustules.



Urediospores of Melampsora medusae.

Monitoring — Examine clones for rust infection in midsummer to late summer. This is especially important for clones thought to be resistant because rust species or races new to an area can develop.

Many species of leaf rust are found on *Populus* spp. Special mention should be made of two species common to other parts of the world, but not believed to be present in North America yet. The most common and serious rust in Europe is *Melampsora larici-populina,* whose common alternate host is *Larix decidua.* *Melampsora larici-populina* is also common in poplar plantings in Asia, South America, and Australia. Another closely related species in Europe is *Melampsora alli-populina,* whose alternate hosts are a number of species of *Allium* and *Muscari comosum.* These two species in Europe can be differentiated by the more reddish color of the summer spore-masses of *M. alli-populina* compared to the more yellowish color of those of *M. larici-populina. M. medusae, M. larici-populina,* and *M. alli-populina* are difficult to differentiate in the field. Microscopic examination of summer spores and careful, controlled greenhouse inoculation studies are required for diagnosis.

Careful monitoring of rust diseases of *Populus* should be part of integrated pest management. Not only can new rust species be imported, but plant rust populations can change and may overcome host resistance over time.

Control —

- Plant only clones that are resistant to leaf rust. This is especially important where the conifer alternate hosts are common.
- Do not plant poplars next to conifer alternate hosts because poplars will become infected early in the summer.
- Wide spacing reduces rust severity in moderately susceptible clones but does not protect highly susceptible clones.

For Additional Information —

Ostry, M. E.; McNabb, H. S., Jr. 1985. Susceptibility of *Populus* species and hybrids to disease in the north central United States. Plant Disease. 69: 755–757.

Ostry, Michael E.; McNabb, Harold S., Jr. 1986. *Populus* species and hybrid clones resistant to *Melampsora*, *Marssonina*, and *Septoria*. Res. Pap. NC-272. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 7 p.

Schipper, A. L., Jr.; Dawson, David. 1974. Poplar leaf rust — A problem in maximum wood fiber production. Plant Disease Reporter. 58: 721–723.

Schipper, A. L., Jr.; Widin, K. D.; Anderson, R. L. 1978. How to identify leaf rust of poplar and larch. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 6 p.

Widin, K. D.; Schipper, A. L., Jr. 1981. Effect of *Melampsora medusae* leaf rust infection on yield of hybrid poplars in the north central United States. European Journal of Forest Pathology. 11: 438–448.

Septotinia Leaf Blotch *(Septotinia podophylina)*

Importance — Infection of *Septotinia* results in extensive leaf necrosis and premature defoliation that can damage young trees in plantations and nurseries.

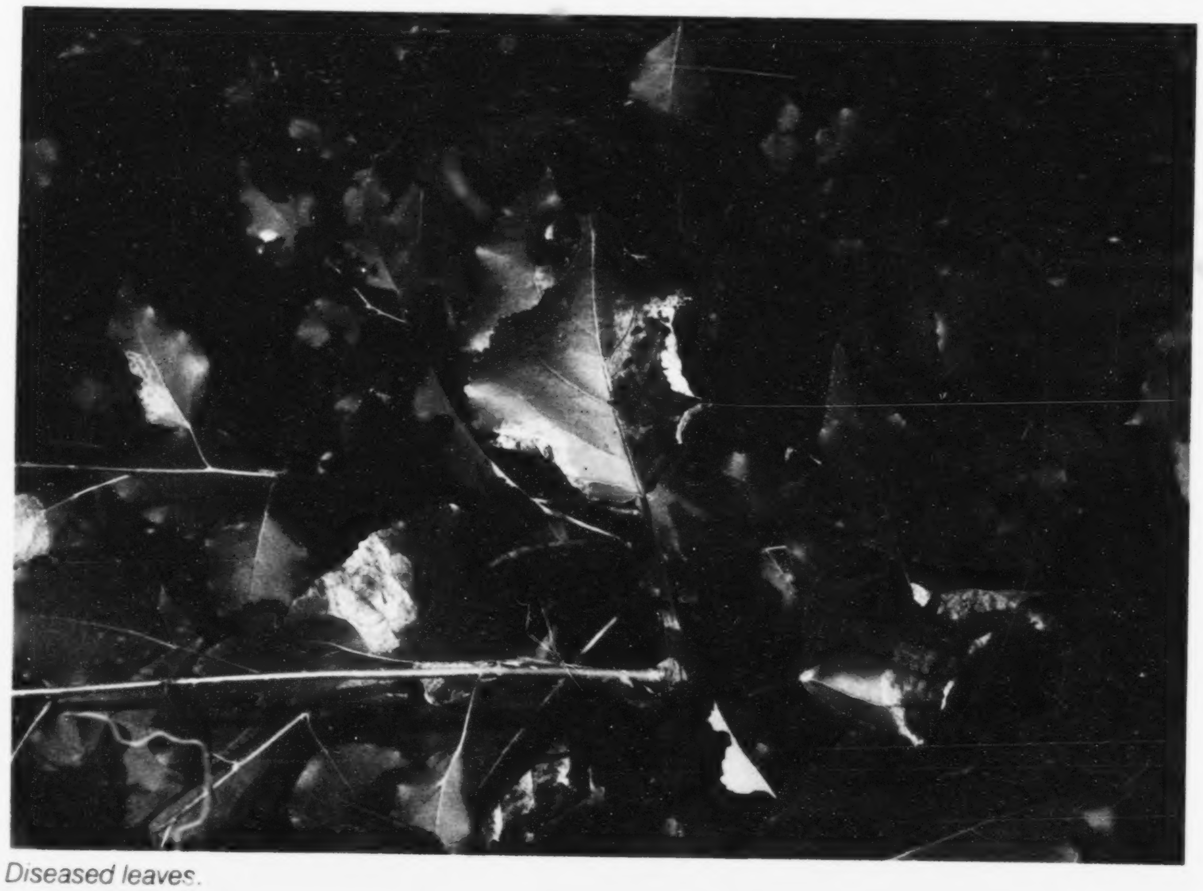
Look For —

- Small brown spots on leaves in spring.
- Large blotches with irregular margins and gray centers in midsummer to late summer.
- White spore-producing structures (sporodochia) and masses of spores (conidia) in concentric circles on the surface of the blotches.

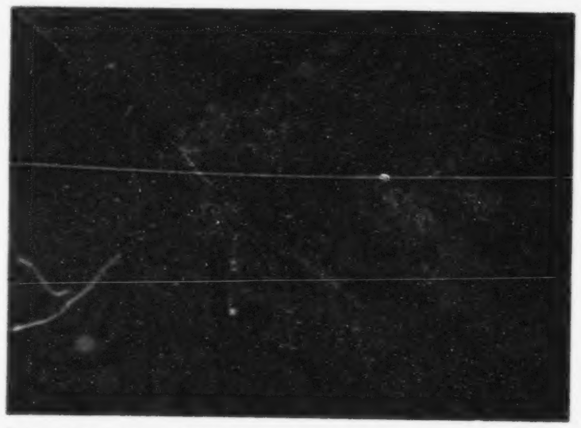
Biology — The fungus overwinters as hard, black bodies (sclerotia) on infected fallen leaves. In the spring, ascospores from fruit bodies (apothecia) in the sclerotia are discharged into the air during wet weather. Spores are carried by wind and rainsplash to developing leaves, where infection takes place. Secondary infections result from conidia that develop within leaf spots being rainsplashed to adjacent leaves. Disease is most common and severe in closely spaced plantings and dense nursery beds where moisture is retained longer on leaf surfaces because of the reduced air movement.

Control —

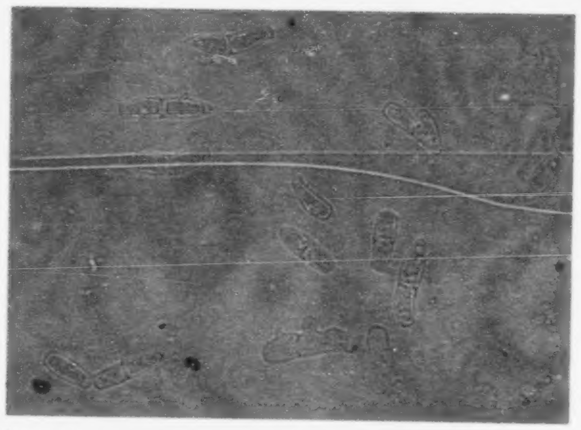
- Direct control is usually not necessary.



Diseased leaves.



Sporodochia. (White spots within leaf blotch.)



Conidia.

- Wider tree spacing and removal of infected leaf debris in late fall or early spring before spore discharge will reduce disease.

For Additional Information —
Ostry, M. E. 1980. How to identify Septotinia and Phyllosticta leaf spots of poplars. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 6 p.

Phyllosticta Leaf Spot (*Phyllosticta* spp.)

Importance — Infection reduces photosynthetic area of severely diseased leaves. Premature defoliation can weaken small trees.

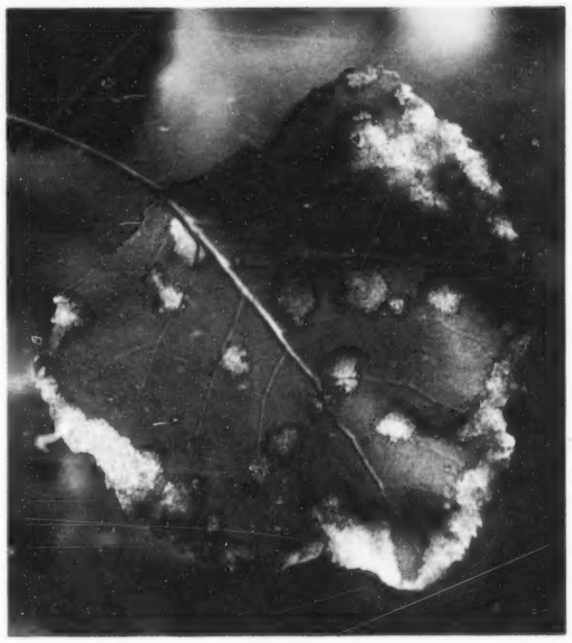
Look For —

- Small brown spots on upper surface of leaves in spring.
- White-gray blotches with black fruit bodies (pycnidia) scattered within the affected areas in midsummer to late summer.

Biology — The fungus overwinters on infected, fallen leaves. Pycnidiospores are rainsplashed to developing leaves in the spring. Secondary infections are caused when pycnidiospores produced in infected areas are rainsplashed to adjacent leaves later in the summer. Disease is most common and severe where air movement is restricted such as in closely spaced plantings where moisture is retained for long periods on leaf surfaces.

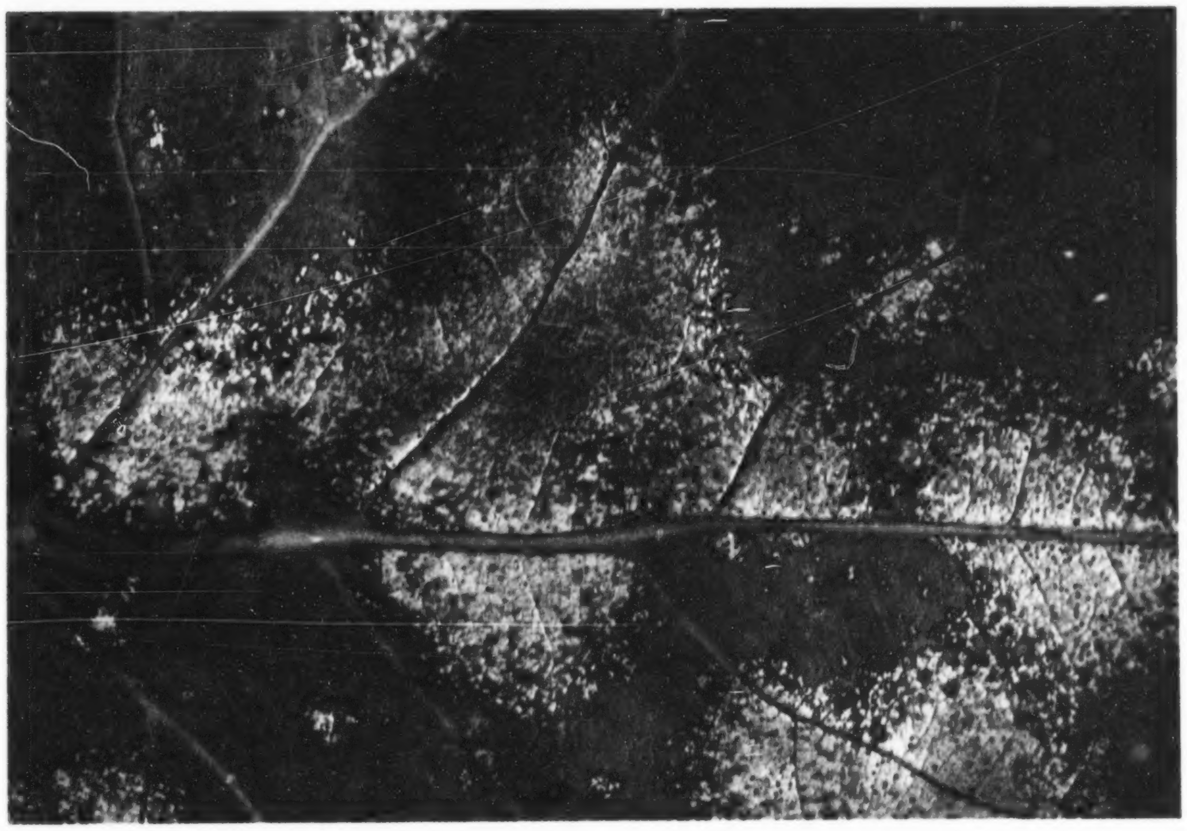
Control —

- Direct control is usually not needed.
- Wider tree spacings and removal of infected leaf debris before spore release in the spring will reduce disease.



Diseased leaf.

For Additional Information —
Ostry, M. E. 1980. How to identify Septotinia and Phyllosticta leaf spots of poplars. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 6 p.



Fruit bodies within leaf spots.

Powdery Mildew (*Erysiphe, Uncinula*)

Importance — Powdery mildew, although conspicuous at times, is of minor importance. Severely diseased leaves may be distorted. However, infection does little damage except where the appearance of leaves is important.

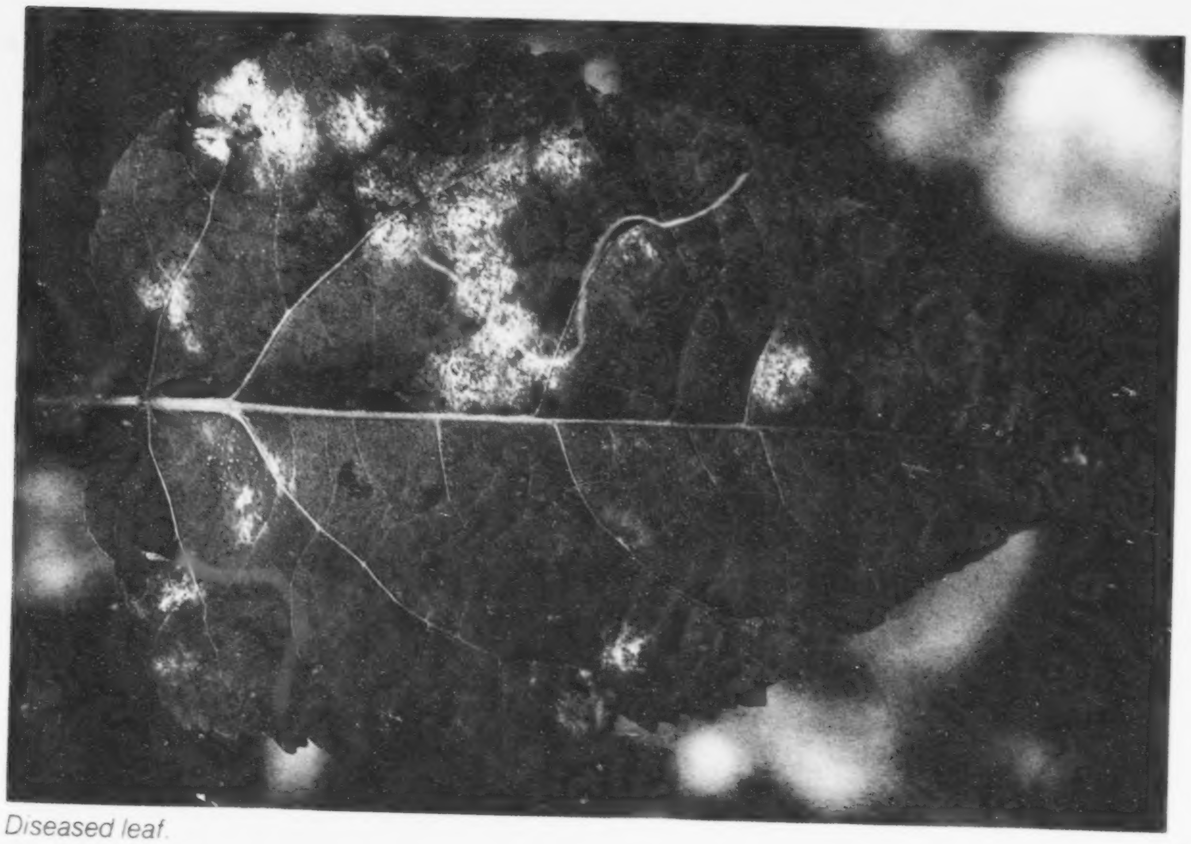
Look For —

- Patches of white-gray powder, sometimes with scattered black fruit bodies on leaf surfaces in late summer.

Biology — Disease is usually most abundant on lower, shaded leaves. Patches of superficial mycelium can enlarge to cover the entire surface of the leaf.

Control —

- Direct control is usually not necessary.
- Apply a fungicide to trees where appearance is important.



Diseased leaf.

Ink Spot, Shot Hole (*Ciborinia* spp.)

Importance — Severe disease can reduce the photosynthetic capacity of leaves and cause premature defoliation. The disease is more severe on aspen and aspen hybrids than on the black poplars.

Look For —
In early summer

- Tan to brown discolored areas with concentric white zones on upper leaf surfaces. Entire leaves may turn brown by midsummer.

In midsummer

- Dark brown-black, raised, hard, oval structures (sclerotia) resembling "ink spots" scattered over the leaf surface.

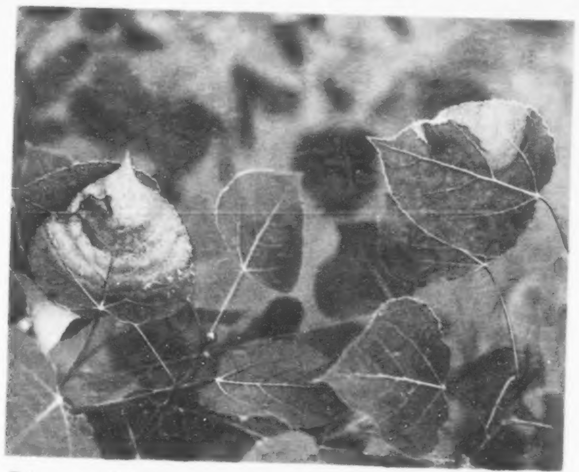
In midsummer to late summer

- "Shot holes" in leaves where sclerotia have fallen out.

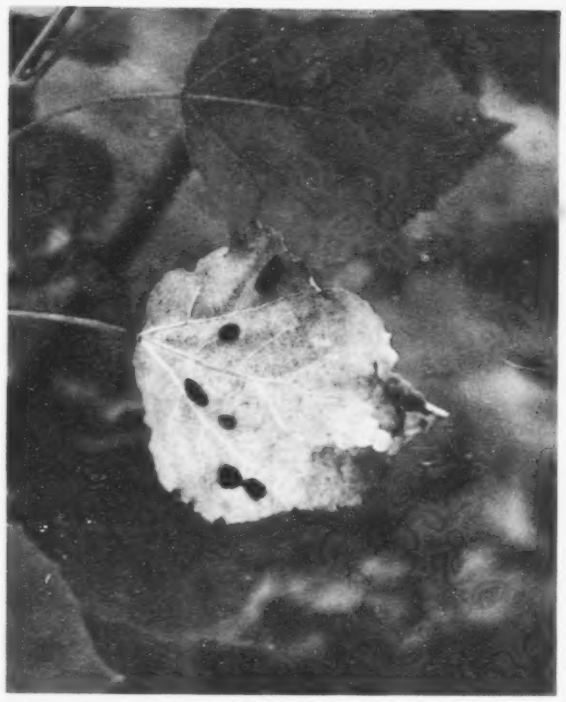
Biology — The fungus overwinters in leaf debris on the ground as sclerotia (masses of hyphae). During moist periods in late spring, fruit bodies (apothecia) develop; ascospores are forcibly discharged into the air and are carried to developing leaves. No further infection occurs until the following spring, when the cycle is repeated.

Control —

- Direct control is usually not needed.
- Bury infected leaf debris and sclerotia in late fall or early spring to reduce inoculum levels in the immediate area and minimize new infections.



Diseased leaves.



Sclerotia. (Ink spots)

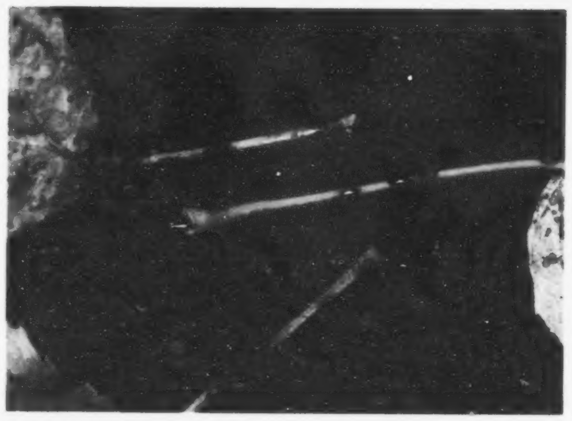
For Additional Information —
Ostry, M. E. 1980. How to identify ink spot of poplars. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 5 p.

Marssonina Leaf Spot (*Marssonina brunnea, M. populi, M. castagnei*)

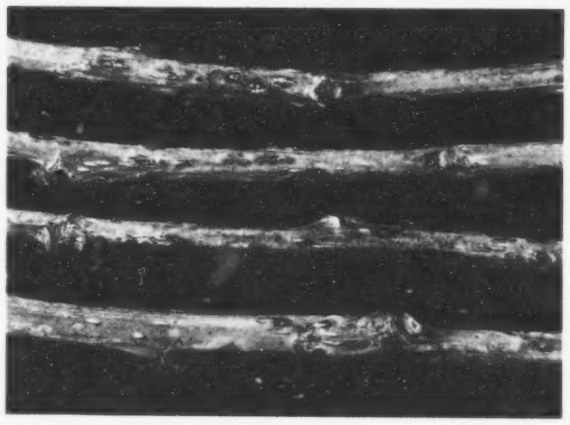
Importance — *Marssonina* spp. cause leaf spots and lesions on petioles and new shoots. Severe disease causes premature defoliation, predisposing affected trees to secondary organisms and environmental stress.

Look For —

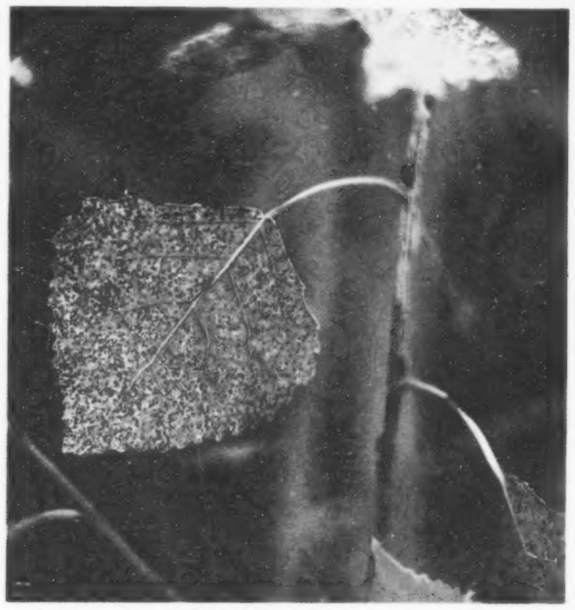
- Small, brownish, circular to angular spots one-eighth inch across, often with a chlorotic halo caused by *M. brunnea,* the predominant species on poplars in the North Central States.
- Large, angular, rust-brown to black blotches characteristic of other *Marssonina* species or of *M. brunnea* when spots coalesce.
- Whitish masses of conidia in centers of spots.
- Lens-shaped lesions with white centers on leaf petioles and new growth.



Petiole lesions.



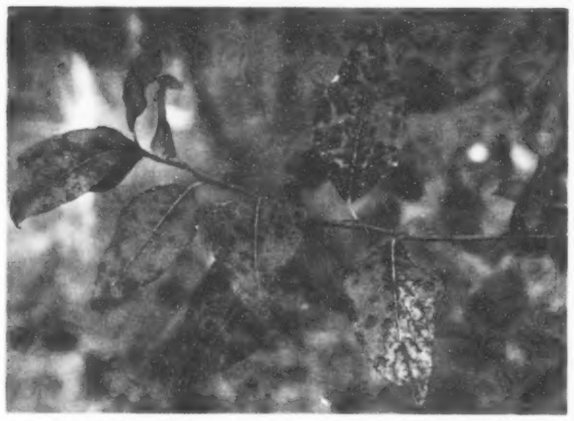
Stem lesions.



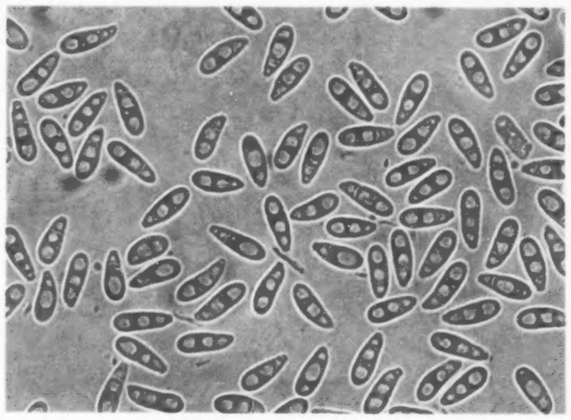
Leaf infected by M. brunnea.

Biology — *Marssonina* overwinters in lesions on the new shoot growth and in fallen infected leaves. Ascospores produced in leaf debris and conidia from lesions on the previous year's shoot growth are released in the spring during wet weather, infecting leaves and new shoots. Conidia produced in these new leaf spots and lesions are rainsplashed to adjacent leaves, causing secondary infections that can become epidemic in midsummer to late summer.

Monitoring — Examine leaves and new shoot growth in early summer for leaf spots and lesions.



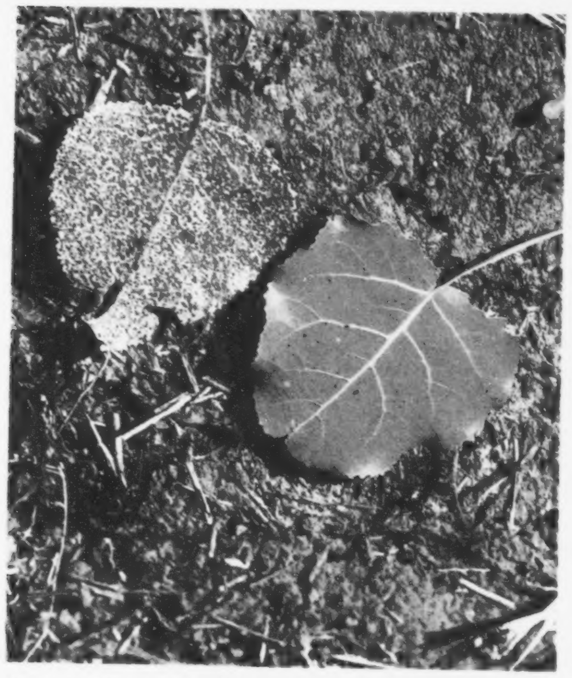
Leaves infected by M. populi.



Conidia of M. brunnea.

Control—

- Plow under leaf debris in late fall or early spring to reduce inoculum in plantations.
- Avoid introducing the fungus to new areas by closely examining planting stock for lesions and destroying infected cuttings.
- Clones differ in susceptibility to *Marssonina*, so plant only resistant clones.



Leaves from susceptible clone (left) and resistant clone.

For Additional Information—

Ostry, M. E. 1987. Biology of *Septoria musiva* and *Marssonina brunnea* in hybrid *Populus* plantations and control of Septoria canker in nurseries. European Journal of Forest Pathology. 17: 158–165.

Ostry, M. E.; McNabb, H. S., Jr. 1983. Diseases of intensively cultured hybrid poplars: a summary of recent research in the north central region. In: Hansen, Edward A., comp. Intensive plantation culture: 12 years research. Gen. Tech. Rep. NC-91. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 102–109.

Ostry, M. E.; McNabb, H. S., Jr. 1985. Susceptibility of *Populus* species and hybrids to disease in the north central United States. Plant Disease. 69: 755–757.

Ostry, Michael E.; McNabb, Harold S., Jr. 1986. *Populus* species and hybrid clones resistant to *Melampsora, Marssonina*, and *Septoria*. Res. Pap. NC-272. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 7 p.

Palmer, Marguerita A.; Ostry, Michael E.; Schipper, Arthur L., Jr. 1980. How to identify and control *Marssonina* leaf spot of poplars. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 5 p.

Spiers, A. G. 1983. Host range and pathogenicity studies of *Marssonina brunnea* to poplars. European Journal of Forest Pathology. 13: 181–196.

Spiers, A. G. 1984. Comparative studies of host specificity and symptoms exhibited by poplars infected with *Marssonina brunnea, Marssonina castagnei*, and *Marssonina populi*. European Journal of Forest Pathology. 14: 202–218.

Resistant clone (left) and partially defoliated clone.

Leaf Blister, Catkin Deformity (*Taphrina aurea, T. johansonii*)

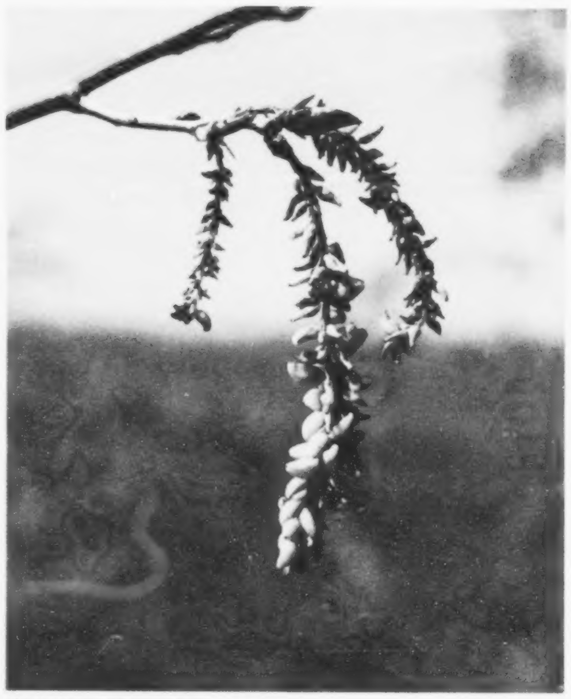
Importance — Leaf blister and catkin deformity occur infrequently and are usually of little importance. Infection of catkins may be important, however, in tree breeding programs where seed production is critical.

Look For —

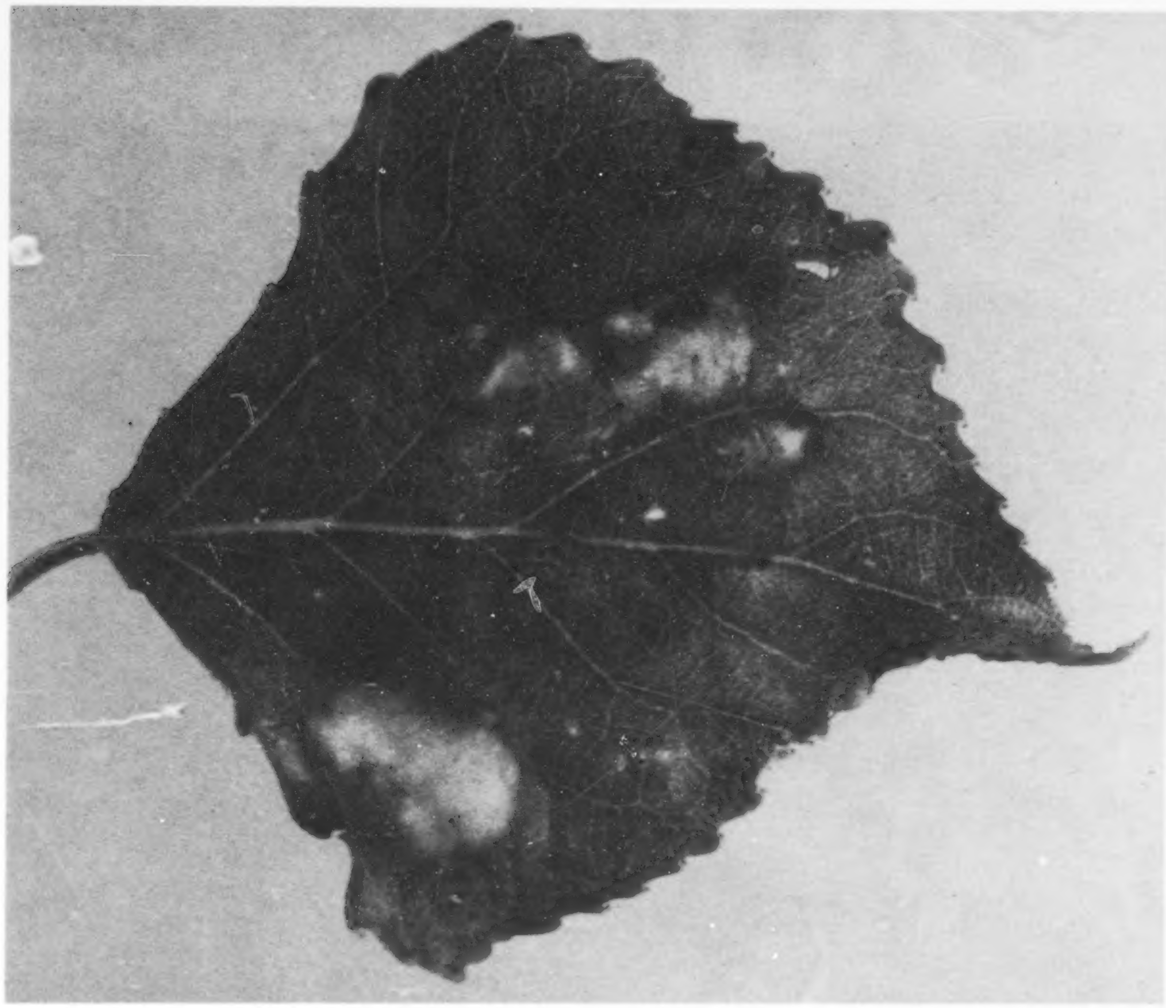
- Blisters on the surfaces of leaves.
- Yellow swellings on female catkins in spring.

Biology — Spores are produced on the surface of blistered leaves. There is only one infection period each year. Infection is caused by overwintering spores being washed onto catkins and leaves in the spring.

Control — Not needed.



Catkin deformity.



Leaf blisters.

Leaf and Shoot Blight (*Venturia macularis, V. populina V. tremulae*)

Importance — The disease is usually most severe in young aspen stands, but it can also affect hybrid poplars. Affected stems and leaves become blackened and distorted. Death of terminal and lateral shoots can distort small trees, causing a shrubby tree form and reducing growth. After repeated attacks, small trees may die because of suppression and infection by other disease organisms.

Look For —

- Irregular, brown to black areas on leaves in early spring.
- Black, brittle shoots that are curled to resemble a shepherd's crook.
- Olive-green appearance of recently infected tissues caused by the layer of spores (conidia) produced.

Biology — Primary infections are predominantly caused by conidia produced from mycelium in shoots killed the previous season. Infection can also result from ascospores that develop in leaves on the ground that were killed the previous season. Conidia are rainsplashed to new shoots and leaves, causing secondary infections that rapidly multiply. Trees growing in dense stands are often more severely diseased than those growing at wider spacings. Only young shoots and leaves are susceptible. Later in the season, as these tissues mature, they become resistant.

Control —

- Direct control is usually not needed.
- Disease severity differs among hybrids, so plant resistant clones.

For Additional Information —

Anderson, N. A.; Anderson, R. L. 1980. Leaf and shoot blight of aspen caused by *Venturia macularis* in northern Minnesota. Plant Disease. 64: 558–559.

Dance, B. W. 1961. Leaf and shoot blight of poplars (Section Tacamahaca Spach) caused by *Venturia populina* (Vuill.) Fabric. Canadian Journal of Botany. 39: 875–890.

Mushroom stage.

For Additional Information—

Prey, Allen; Robbins, Kathryn. 1979. Armillaria root and butt rot. Pest Alert NA-FB/U-6. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State & Private Forestry. 1 p.

Stanosz, G.R.; Patton, R.F. 1987. Armillaria root rot in aspen stands after repeated short rotations. Canadian Journal of Forest Research. 17:1001–1005.

Miscellaneous Diseases and Parasites

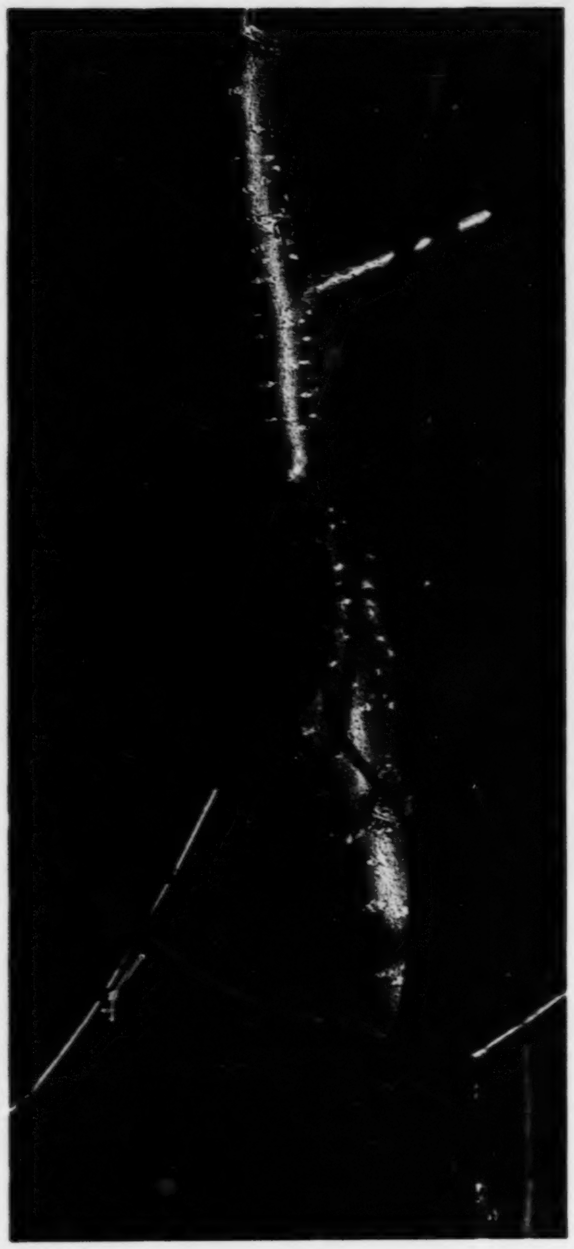
Miscellaneous Diseases and Parasites

Crown Gall (*Agrobacterium tumefaciens*)

Importance — This bacterium causes unsightly galls on roots, trunks, and branches of infected trees. Galls can disrupt food and water-conducting tissues, resulting in poor growth of young trees. In addition, stems can break at galls, and galls serve as entry points for stain and decay fungi.

Look For —

- Globular-shaped small galls.
- Irregular-shaped, deeply fissured growths, later becoming spongy.
- Bacterial slime in fissures of galls when very humid.



Branch gall.

Trunk galls.

Biology — Crown gall is caused by a bacterium that survives in the soil and infects trees through wounds. Insects, rainsplash, soil particles, and pruning tools can harbor the bacterium and spread it to other trees and fields. *Agrobacterium tumefaciens* causes a cancer-like proliferation of cells by disrupting the host plant's DNA. The bacterium can infest the soil when outer cells of galls are sloughed off.

Control —

- Do not plant in soil infested with the bacterium.
- Do not propagate infected stock.
- Destroy infected plants.
- Use care in cultural practices to avoid spreading the bacterium to other fields or plants on equipment.
- Biological control by a non-gall-forming strain of the bacterium *A. radiobacter* has been successful in fruit orchards. This material is available commercially for either a preplant dip or for treatment after planting.

Wetwood (*Corynebacterium*)

Importance — Poplars commonly develop wetwood, a water-soaked condition accompanied by a darkening of the wood. Premature death of poplars, especially of Lombardy poplar, has been associated with wetwood. Lumber made from wetwood is weaker than sound wood and is subject to checking and collapse during drying.

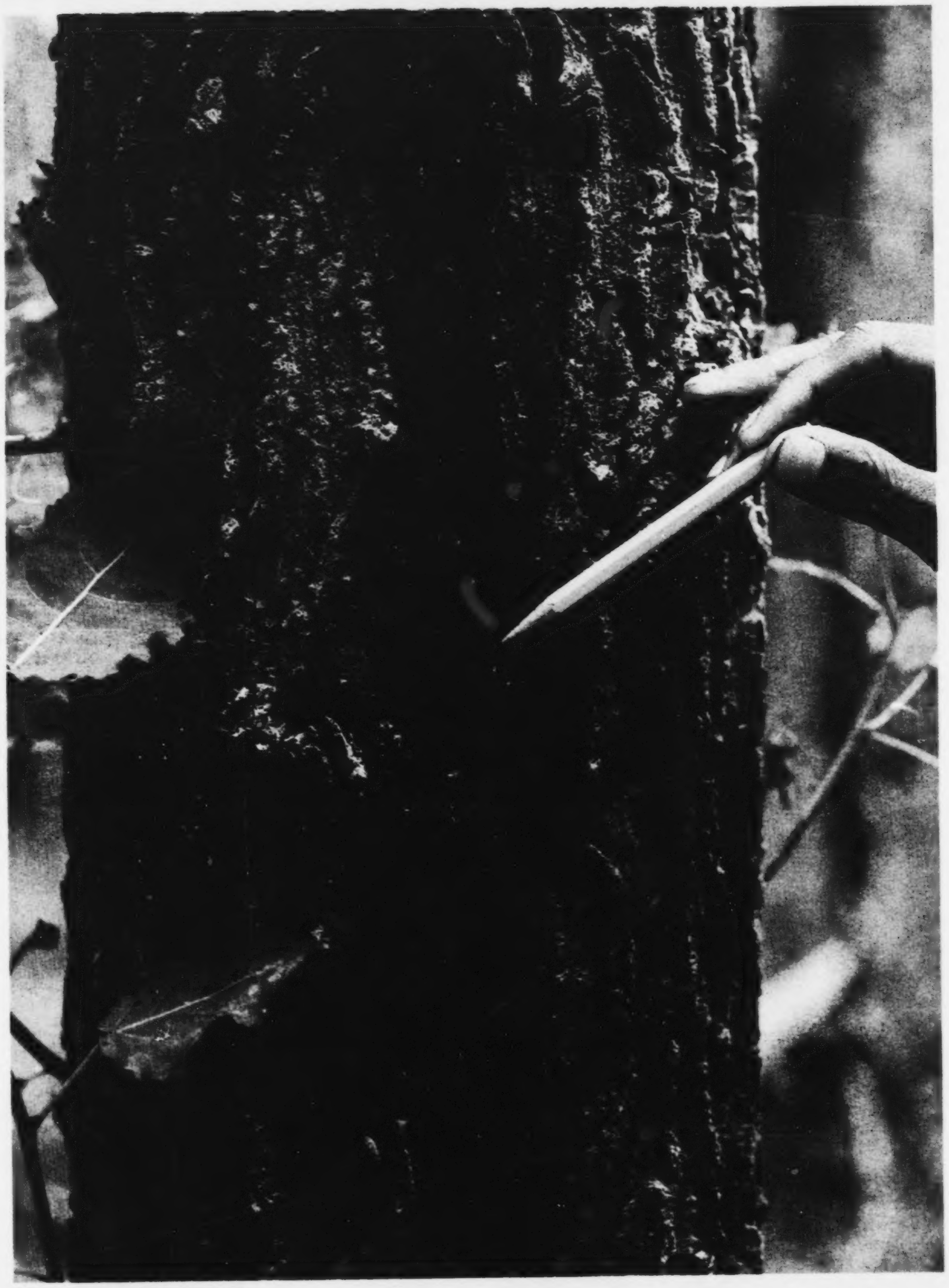
Look For —

- Water-soaked appearance of trunk.
- Slime flux at a wound or branch stub.
- Reddish darkening and water-soaked condition of wood when tree is cut.
- Branch dieback, tree decline.

Biology — Bacteria are implicated by many investigators as causing wetwood. *Corynebacterium humiferum* has been associated with wetwood of Lombardy poplar. However, we don't know the exact role of the many other microorganisms present in trees affected by wetwood. Furthermore, other investigators believe wetwood is formed by a nonmicrobial process and supports a succession of bacteria after it develops.

Control —

- No control is known.
- Wetwood is not a problem if trees are grown on short rotations or if wood quality is not critically important.



Slime flux on affected tree.

Miscellaneous Stem Deformities (*Burls, Fasciations*)

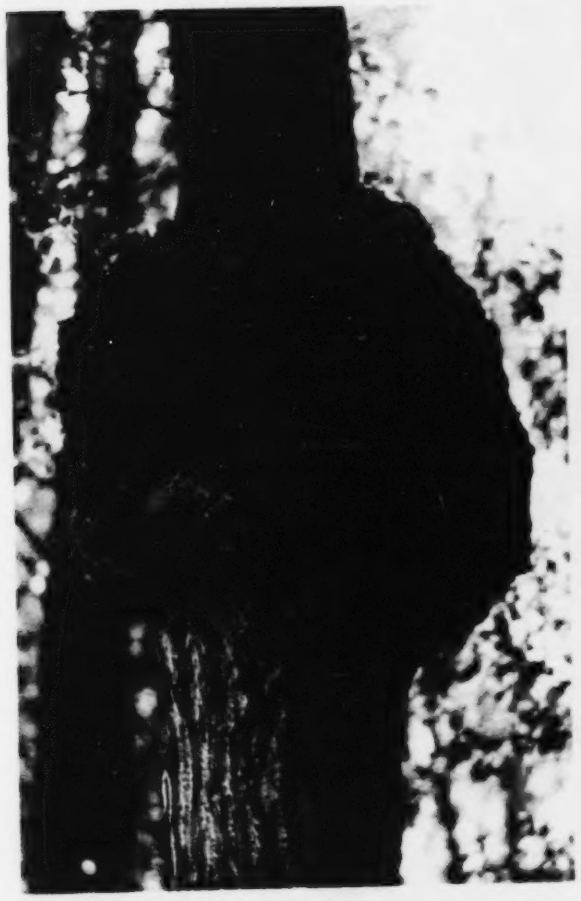
Importance — These rare stem deformities are of minor importance except where tree appearance is important. Stain and decay may be associated with large stem deformities.

Look For —

- Large growths on stems with intact bark.
- Flattened stems and branches of sapling trees.

Biology — Burls are tumor-like growths that have not been associated with any pathogenic agent. Fasciations are a flattening of portions of branches from an unknown cause.

Control — No control is needed.



Burl.

Fasciation.

White Trunk Rot (*Phellinus tremulae*)

Importance — White trunk rot causes more wood volume loss in aspen than any other disease. Advanced decay and discoloration greatly reduce the value of trees as fiber sources. This rot is not a problem in plantations managed on short rotations.

Look For —

Standing trees:

- Hoof-shaped conks (fruit bodies). Conks are dark brown to black on the upper surface and light brown on the lower surface. The interior is dark brown with white flecks.
- Punky knots filled with dark brown material resembling the interior of conks.
- Trees with large branch stubs, broken tops, cankers, fire scars, and other old stem wounds.

Fruit bodies (conks) of Phellinus.

Cut trees:

- Yellowish-white wood surrounded by a zone of dark, discolored wood (early stage of decay).
- Spongy, yellowish, wood surrounded by irregular black zones of discolored wood (advanced decay).

Biology — *Phellinus* is a wound parasite that infects trees when spores (basidiospores) from conks land and germinate on suitable substrates. By the time large or multiple small conks become visible on infected trees, decay is usually extensive. Generally, less volume is lost in vigorous stands on good sites than in stands on poor sites.

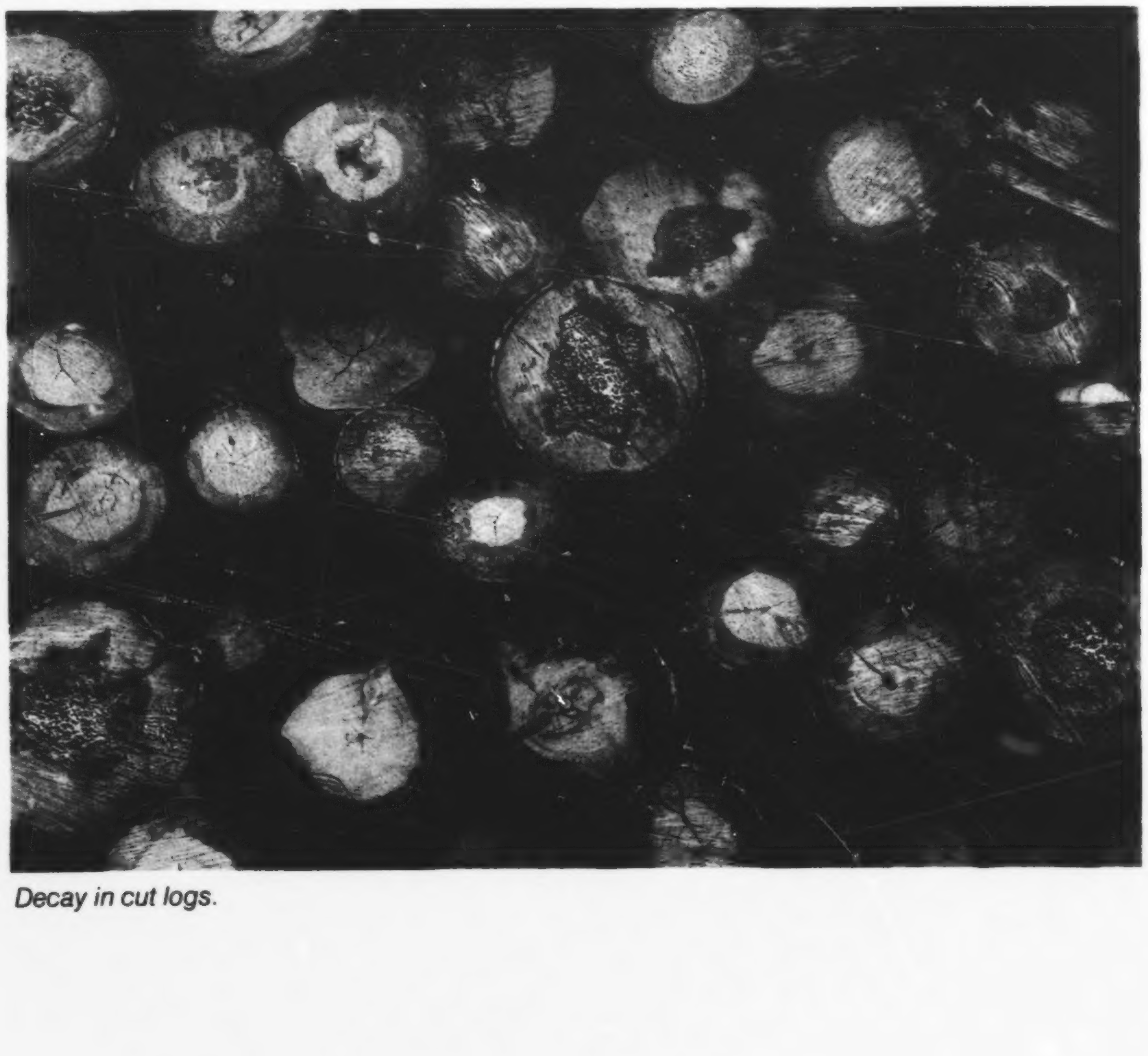
Monitoring — White trunk rot becomes more severe with stand age. In parts of the Lake States, aspen stands begin to deteriorate rapidly when they reach 50 to 60 years. Mature stands and stands damaged by fire, wind, ice, and other agents, should be considered for harvest before damage becomes too great. The volume of wood affected by hidden decay (early stage of decay or trees with no visible symptoms) can be equal to the volume of decay in trees with symptoms.

Control —

- No direct control is known, but loss can be minimized by harvesting aspen before decay becomes extensive.
- Harvest stands damaged by fire or weather early because such stands are susceptible to infection.
- Make regeneration cuts in overmature, defective aspen stands to bring these sites back to full production.
- Manage aspen to achieve uniform, well-stocked stands so natural pruning will minimize infection sites.

For Additional Information —

Ostry, Michael E.; Walters, James W. 1983. How to identify and minimize white trunk rot of aspen. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 5 p.



Decay in cut logs.

Mistletoe (*Phoradendron* spp., *Viscum album*)

Importance — *Phoradendron* spp. are found in parts of the Eastern, Western, and Southern United States. *Viscum album,* common in Europe, is not a problem on poplars in the United States. Severely infected trees are weakened, predisposing them to insect attacks and to environmental stresses. Branch and trunk swellings caused by mistletoe reduce wood quality and serve as points of entry for stain and decay fungi.

Look For —

- Individual, or clumps of green flowering plants with white to pink berries in the fall.
- Branch or trunk swellings.

Biology — Mistletoes are parasitic plants that depend partially on their host for support, water, and mineral nutrients. Male and female flowers are borne on separate plants. The parasite is spread by birds that eat the berries and then excrete the seeds. The sticky seeds adhere to branches, where they germinate. A penetration structure forces its way through the bark where the root system of the plant then develops within the branch. While the root system slowly spreads outward from the point of infection, the aerial portion of the plant develops. Several years are required from the time of infection until a seed bearing plant is mature.

Mistletoe plant.

Clumps of mistletoe plants.

Monitoring — Mistletoe is most easily detected in the fall and winter after leaves are off the trees.

Control —

- Mistletoe will not be a problem on poplars grown on short rotations, so no control is needed.
- Removing the aerial portion of mistletoe does not eliminate the problem because the parasite can survive within the host tissues and eventually produce new shoots. However, removing that portion reduces stress on the tree and also makes fewer seeds available for additional infections.
- Remove infected branches to eliminate the root system of the mistletoe.

For Additional Information —

Scharpf, Robert F.; Hawksworth, Frank G. 1974. Mistletoe on hardwoods in the United States. For. Pest Leafl. 147. Washington, DC: U.S. Department of Agriculture, Forest Service. 7 p.

Vertebrate Damage

Vertebrate Damage
Deer, Elk, Moose, Mice, Voles, Rabbits

Importance — Bark-eating mammals can damage stems and shoots. They may kill trees by girdling stems near the ground.

Look For —

- Bark hanging in shreds on tree stems.
- Small teeth marks on exposed wood at or near the ground line.
- Large notches where bark has been removed on tree stem.
- Small stems cut off near ground line.
- Upper shoots of small trees nipped off.

Biology — Young trees are especially susceptible to damage by bark-eating mammals during winter. Rabbits frequently clip young shoots during winters of heavy snowfall when other browse is scarce. Tall grass and other heavy ground cover around trees increase the likelihood of damage by mice and voles feeding on the bark during winter, especially in years of large populations. Stems are injured by big game animals rubbing their antlers on them or by gnawing or stripping bark off trees with their incisor teeth. Secondary fungi often enter trees through wounds caused by animals, compounding the damage.

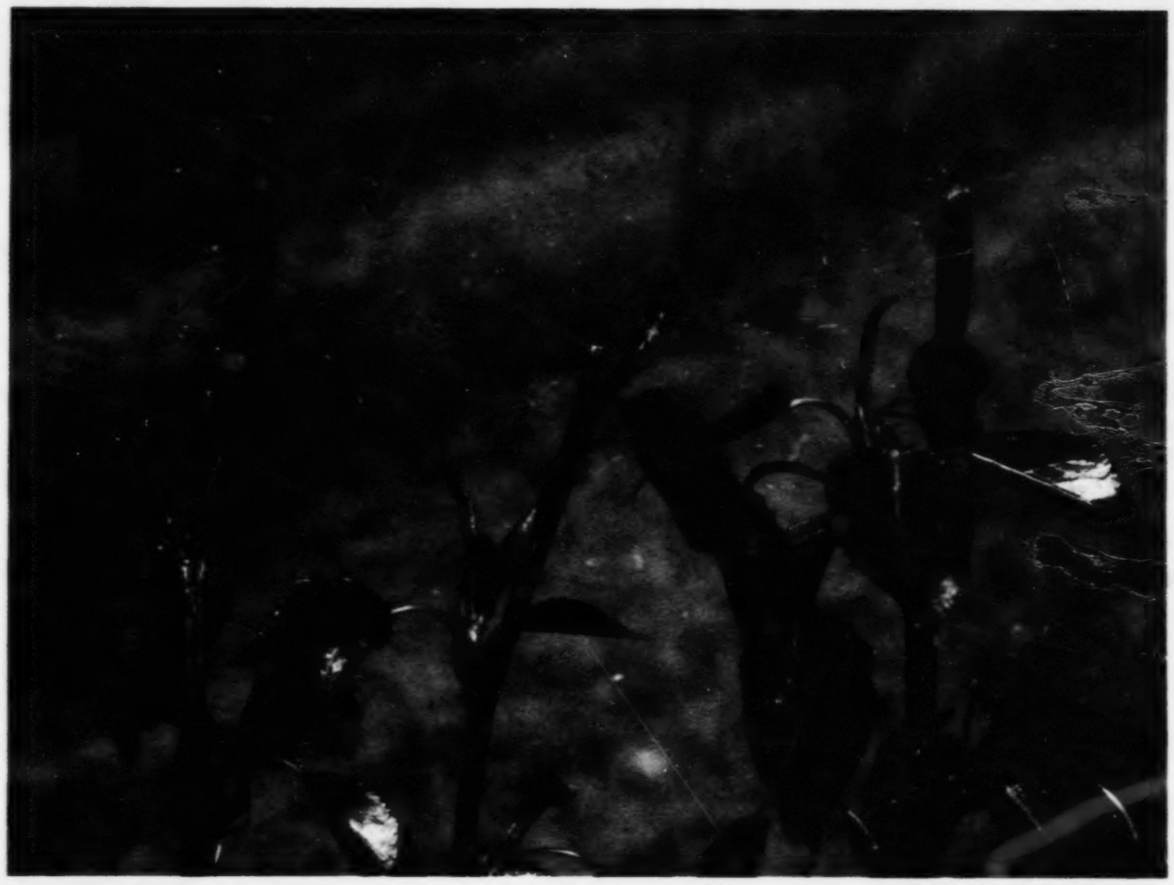
Rabbit damage.

Control —

- Good grass control will minimize damage by mice and voles.

Deer rub.

Mouse-girdled tree.



Deer browsing damage.

- Apply physical barriers around tree stems to discourage small mammals from feeding.

- Apply repellents to protect trees in plantations and nurseries by discouraging animals from feeding on them. Some animals prefer certain clones, so do not plant favored clones in areas where animal damage is common.

For Additional Information —

Dickmann, D. I. 1978. Marked differences among poplar clones in winter browsing damage by cottontail rabbits. Canadian Journal of Forest Research. 8: 351–354.

Verch, Richard L. 1979. Feeding preference of penned white-tailed deer for hybrid poplar clones. Res. Note NC-248. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 2 p.

Defoliators and Leaf Feeders

Imported Willow Leaf Beetle (*Plagiodera versicolora*)

Importance — Imported from Europe in 1915, this leaf beetle is widely distributed in the Eastern United States and Southern Canada and has been sporadically reported throughout North America. In Europe, this insect is especially important in young plantations where impact can be severe. Beetle populations in North America have been kept at low levels by an imported pupal parasite. This insect is potentially more important than the cottonwood leaf beetle because of its ability to defoliate large trees as well as saplings and *Populus* species with leaf pubescence.

Look For —

- Signs of feeding defoliation — skeletonizing or small holes being cut through the leaf; blackened shoots containing skeletonized small leaves. Heavily infested trees may turn brown to brown-black as early as mid-June.
- Oval, metallic blue to greenish-blue beetles, less than one-fifth inch long, often in clusters feeding on poplar or willow leaves beginning in late April and May and continuing through the growing season.
- Later in the spring, nearly jet-black larvae with rows of protuberances running both across and longitudinally on their bodies, about one-fifth inch long when fully grown. These larvae also feed on poplar and willow leaves.

Biology — Two to three generations are found in New England; five generations are found in Virginia and North Carolina. Adult females lay irregular masses of eggs on leaves. The larvae feed gregariously, skeletonizing the leaves. Adults overwinter under bark or in grass or debris around and near the bases of trees.

Control —

- Low winter temperatures and an imported pupal parasite have held down population levels of this beetle in most areas of the United States, indicating that direct control measures may not be needed.
- During severe infestations, this beetle can be controlled by following the recommendations given for the cottonwood leaf beetle.

Leaves skeletonized by imported willow leaf beetles.

Adult willow leaf beetles congregating on leaves.

Satin Moth (*Leucoma salicis*)

Importance — The larvae of this introduced insect defoliate pole-size *Populus* in natural stands and plantations in the New England States and southeastern Canada, Washington, and Oregon. Larvae of this moth may kill branches, but rarely trees.

Look For —

April–May:

- Defoliated trees — leaves eaten except for large veins.
- Black caterpillar about 1½ to 2 inches long with line of yellow or white spots on the back. Each segment has reddish brown tubercles with hairs.

June–August:

- Satiny white moths on foliage.

Biology — Female moths lay up to 1,000 eggs in clusters on the shoots, trunk, or leaves in June and July. Larvae appear in August and feed on the leaf surface until cold weather. After overwintering, the small larvae resume feeding when the weather warms. When fully grown by the end of May, they pupate in cocoons attached to the tree or other nearby objects. The adults emerge in June.

Monitoring — Inspect trees in spring for defoliation and larvae. Control is seldom needed unless trees are defoliated for several years in a row. Consider treatment only if trees show branch or top dieback.

Life stages of the satin moth: egg mass (upper right), black pupa, spotted larva, and white moth.

Control —

- Use Bt (*Bacillus thuringiensis*) in spring to control larvae.
- Use a chemical insecticide recommended for defoliators.

Sarrothripus Moth (*Sarrothripus frigidana*)

Importance — Larvae consume leaves of young poplars and willows in nurseries and outplantings throughout North America. This insect's primary native host is balsam poplar, but it seldom seriously injures this species. Preferring 1- or 2-year-old trees, *Sarrothripus* may defoliate the upper crown of whips or young trees, causing growth loss and tip dieback.

Look For —

June–August:

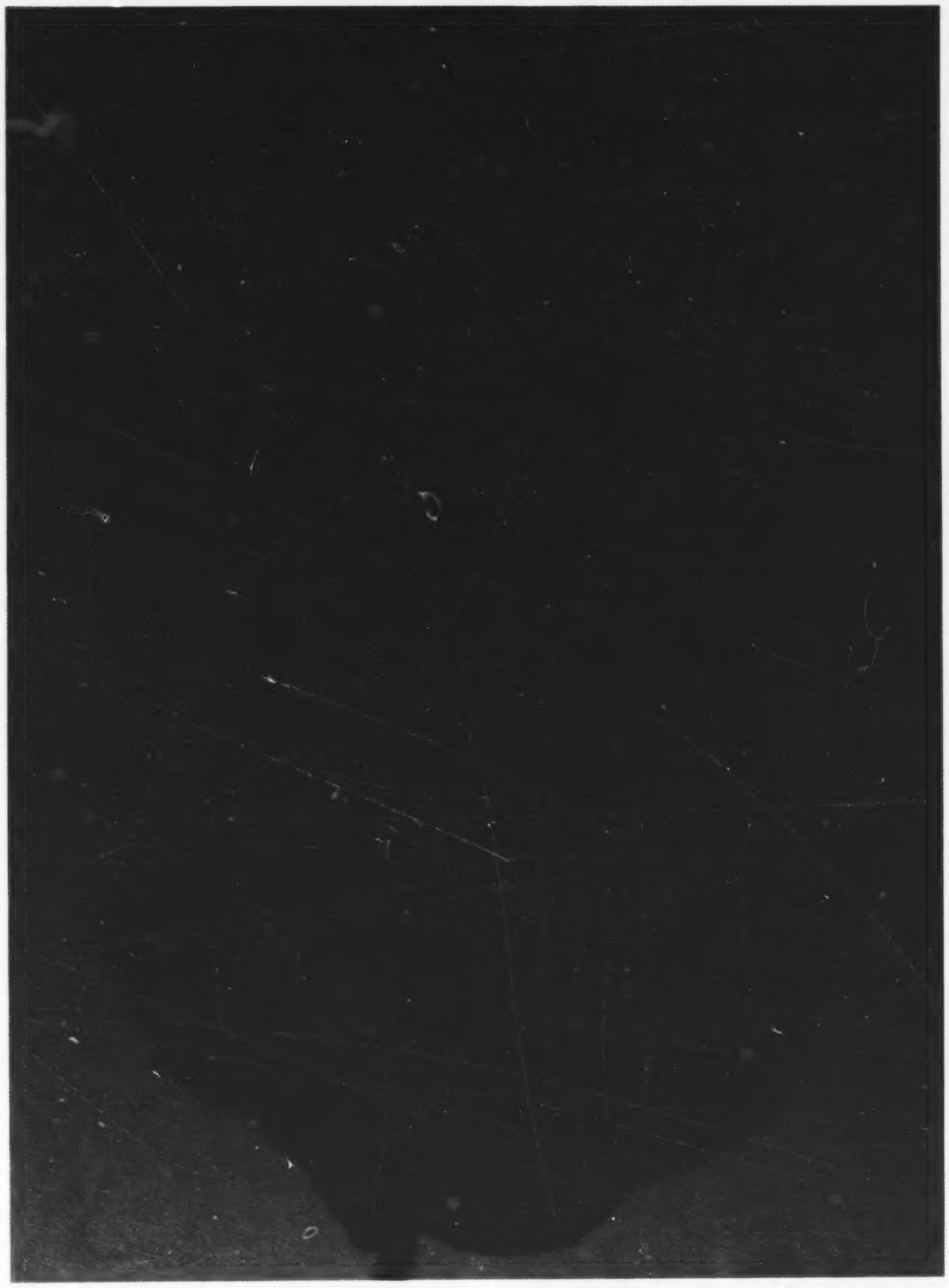
- Small yellow eggs in clusters of 2 to 5, near base of leaf petioles.

July–September:

- Leaves cupped and the openings covered with webbing, especially leaves in the upper crown or at ends of branches. Leaf surfaces skeletonized.
- Green or yellow larvae up to 1 inch long under the webbing.

Biology — This insect may have two generations each year. The female moth lays her eggs in small clusters at the base of leaves. When the larvae hatch, they migrate to the leaves and spin webs over the

Egg cluster of Sarrothripus moth.



Sarrothripus larvae feeding on cupped leaf.

surface, making a tent in which they feed. Larvae move to new leaves after consuming the old ones. Mature larvae pupate in silken cocoons, either on the plant or in the soil beneath the crown. The insect is difficult to control with standard insecticides because the webbing reduces insecticide penetration.

Monitoring — Inspect whips or 1- to 2-year-old trees when leaves are nearly expanded. Examine 25 to 50 leaf clusters near the growing tips for eggs, webbing, or larvae. Treat nurseries if 20 percent of the whips are attacked. Treat plantings only if more than 50 percent of the trees are attacked or if dieback occurs in 20 percent or more of the trees.

Control —

- Apply a commercial preparation of Bt (*Bacillus thuringiensis*).
- Spray heavily infested trees with a systemic insecticide to control the larvae.

Large Aspen Tortrix (*Choristoneura conflictana*)

Importance — The larvae of this insect are voracious feeders that destroy the buds and leaves of *Populus* in the Northern United States and Canada. Outbreaks frequently last for several years and then disappear. Heavily and repeatedly defoliated trees or trees with buds removed lose vigor and may die.

Look For —

- Tightly rolled leaves.
- Greenish larvae or brown pupae on the rolled-up leaves in early summer.

Biology — In mid-June, female moths lay their eggs in large clusters on the upper surface of leaves. The young larvae emerge in about 10 days and feed gregariously inside leaf shelters. The larvae overwinter in protected places. In spring, they emerge, penetrate the opening buds, and feed. Later they roll the leaves and feed inside them until pupation in July.

Monitoring — Check trees for injured tips or rolled leaves in the spring and summer. Consider control only if trees are more than 90 percent defoliated or if heavy defoliation occurs 2 or more years in a row. Natural factors usually keep the populations in check after 2 or 3 years.

Control —

- It is usually impractical to control the insect in extremely large areas. In small stands, apply Bt (*Bacillus thuringiensis*) when the insects are in the early larval stages.
- Apply a registered contact insecticide to the trees after larvae become active in the spring or when larvae migrate to overwintering sites in the fall.

Rolled leaf.

Large aspen tortrix larva.

Mourningcloak Butterfly (*Nymphalis antiopa*)

Importance — The larvae, feeding in clusters, consume large quantities of foliage and rapidly defoliate trees of all sizes in nurseries and plantations throughout North America. Trees are weakened from defoliation, and twice-defoliated trees may die or dieback and resprout.

Look For —

- One or more branches partly or completely devoid of foliage.
- Clusters of spiny, blackish, red-spotted larvae up to 2 inches long on the leaves and shoots.

Biology — At least two generations occur each year. The bufferflies hibernate; and as soon as the weather warms, the females lay masses of 300 to 450 eggs on poplar shoots. The larvae feed gregariously and consume all foliage except the largest leaf veins. Fully grown larvae form chrysalises on the shoots, and the distinctive black and yellow butterflies emerge within a week. The second generation follows and the adults overwinter.

Tree defoliated by mourningcloak larvae.

Mourningcloak larvae.

Monitoring — Inspect trees in early summer and again in late August for spiny colorful caterpillars and injured leaves. Treat infested nursery beds when larvae are present. In plantations, treat each infested tree to reduce the population or wait until 10 percent of the trees are infested in the second generation.

Control —

- Allow parasites and predators to build up when larvae are not threatening the trees.
- Treat with a commercial preparation of Bt (*Bacillus thuringiensis*) as soon as larvae start feeding.
- Apply a chemical insecticide for leaf-eating larvae when the caterpillars are feeding.

This insect has many natural enemies that build up rapidly.

For Additional Information —

Becker, W. B. 1938. Leaf-feeding insects of shade trees. Bull. 353. Massachusetts Agricultural Experiment Station. 83 p.

Webs and cast larval skins of the mourningcloak larvae.

Leafminers
Several Groups

Importance — The larvae of several species of insects make irregular serpentine or blotch mines inside the leaves. Usually they are not a threat to *Populus*, although they occasionally cause some early leaf fall.

Look For —

- Leaves with serpentine mines or blotches of brown tissue where the leaf is hollowed out. Small larvae may be in the mined areas.

Biology — The adult female lays eggs on the leaves; the larvae then enter the leaf tissues and feed on the parenchyma. When full-grown, they pupate within the leaf or on the leaf margin.

Monitoring — Check trees for blotch leaf mines. Consider treatment only when more than 80 percent of the leaves are mined. Treat the next spring to get the new-generation insects. Most serpentine leafminers attack late in the season and cause little concern, even when conspicuous.

Control —

- Spray trees or apply a granular systemic insecticide in spring at dosages recommended for leafmining insects.

Serpentine leaf miner.

Blotch miner damage.

Grasshoppers (*Acrididae*)

Importance — Grasshoppers ordinarily are not a pest of *Populus* trees, but they may injure young trees when grasses and field crops are scarce. Heavy infestation can defoliate, debark, and kill trees.

Look For —

- Ragged leaves that have been partly chewed or completely chewed off.
- Scarred bark on twigs and branches.
- Adult grasshopper up to 1¼ inches long on the foliage or twigs in summer.

Ragged foliage and grasshopper.

Biology — Eggs are deposited in pods in the soil from late summer to fall. Nymphs hatch in May and June. All stages feed on foliage until the onset of cold weather. If food is scarce, they will migrate long distances in search of anything edible.

Monitoring — Inspect young trees from late June to late October in areas with heavy grass or adjacent to areas with heavy grass. Treat the entire area if 10 percent of the trees are heavily defoliated.

Control —

- When planting old pastures to *Populus*, plow land in late fall to expose overwintering egg pods to winter temperatures.
- Treat with a recommended insecticide or bait in August or September.

Viceroy Butterfly (*Basilarchia archippus*)

Importance — Because the larvae live alone, little injury occurs during most of the growing season. However, late-season larvae feed on tender terminals and buds, killing up to 10 inches of the growing tips, which results in multiple-forked crowns. Heavily injured trees are of little value. The viceroy is seldom important as a nursery pest.

Look For —

- Ragged partly consumed leaves near branch ends.
- Larvae up to 1½ inches long resembling an elongated bird dropping on the leaves. The body is a mixture of either olive green and white or brown and white. Two brown tubercles are on the thorax just behind the head.
- Orange and black butterfly resembling the Monarch butterfly, but smaller and with a narrow black line across each hind wing.

Biology — The number of generations per year increases from North to South. Eggs laid on the leaves produce larvae that feed solitarily on the leaves. When fully grown, the larvae form a brown and white chrysalis on the stem or branch. The adult butterfly emerges soon after and once again lays eggs on the leaves. In late fall, small larvae prepare to overwinter in rolled-up leaves.

Monitoring — Inspect young plantings in the first 3 years for injury and larvae in midsummer. If 10 percent of infested trees show evidence of bud or shoot feeding, treat with an approved or registered insecticide.

Control —

- Apply a commercial preparation of Bt (*Bacillus thuringiensis*) as soon as larvae are feeding.
- Spray infested trees with a chemical insecticide recommended for leaf-eating caterpillars.

Larva of viceroy butterfly.

Forest Tent Caterpillar (*Malacosoma disstria*)

Importance — The larvae of this common insect defoliate all species of *Populus*. Outbreaks occur periodically and cause widespread defoliation.

Look For —

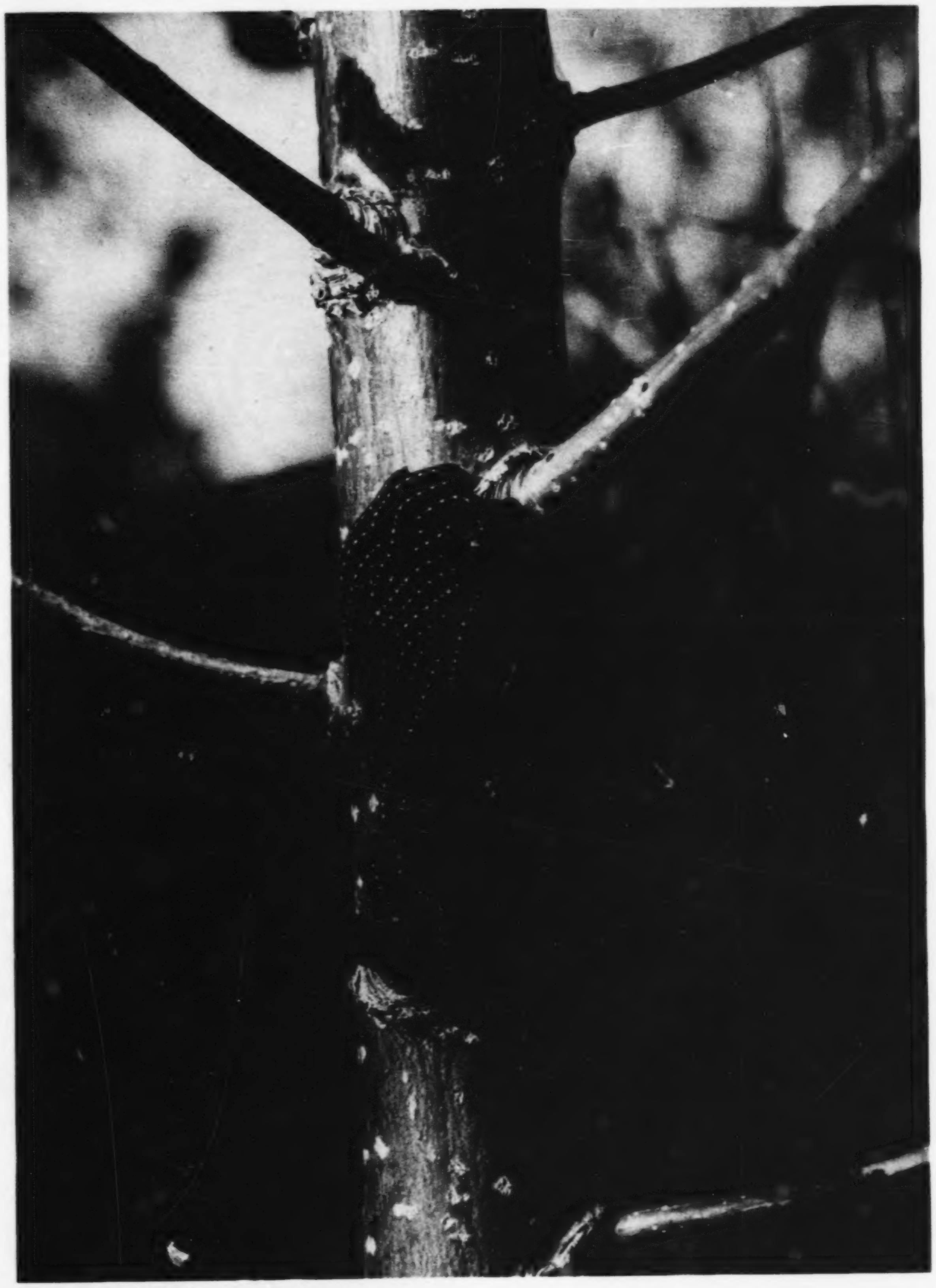
- Partly or completely defoliated trees.
- Bluish larvae 1½ to 2 inches long with white keyhole-like markings up and down the back. Tan brown hairs adorn the sides.
- Yellowish cocoons with black pupae on the leaves or shoots.
- Black-gray egg masses around shoots in fall and winter.

Biology — There is one generation a year. Larvae emerge and feed 5 to 6 weeks on the foliage. At first the larvae are highly gregarious, but later they split into small groups. Cocoons are formed in August. Moths emerge about 10 days later, and the females lay eggs that overwinter in a mass in a band around the small shoots.

Monitoring — Check trees for defoliation or larvae in early summer; consider treatment if more than 60 percent of the leaves are injured or trees have been heavily defoliated 2 years in a row. Survey for egg masses in winter or fall after leaves have dropped. If there is more than one egg mass per branch, consider control the following year.

Control —

- It is usually impractical to control this insect in extremely large areas. In small stands, apply Bt (*Bacillus thuringiensis*) or a recommended chemical insecticide when the insects are in the early larval stages.



Cluster of forest tent caterpillar larvae.

Bagworm
(*Thyridopteryx ephemeraeformis*)

Importance — Larvae feed on foliage, rendering the trees weakened and unsightly. The bagworm is an occasional pest on *Populus* throughout Eastern North America, but common in the east-central United States and destructive only when the insects reach outbreak numbers on favored hosts nearby. Heavily defoliated trees are rare in the forest.

Look For —

- Sparse foliage all over tree.
- Brown, silken, football-shaped bags 1½ to 2 inches long, covered with leaves and small twigs on the shoots.

Biology — The female moth deposits her eggs inside the silken bag in the fall. The larvae hatch in the spring, disperse, and build their own bags from which they feed until fall. Because the wingless female never leaves the bag and the larvae feed nearby, damage is usually limited to individual trees.

Monitoring — Examine trees for small bags after the growing season begins. Treat affected trees when defoliation exceeds 80 percent or when trees are defoliated heavily 2 years in a row.

Control —

- Hand pick bags when practical.
- Apply a commercial preparation of Bt (*Bacillus thuringiensis*) as soon as larvae start feeding.
- Spray heavily infested trees with a recommended chemical insecticide for leaf-feeding insects.

Bagworm bag.

Fall Webworm
(*Hyphantria cunea*)

Importance — The larvae of this web maker feed on more than 100 species of trees but moderately prefer *Populus*. Trees of all sizes may become covered with webs. Although spectacular because of its heavy webbing, the insect has little effect on the tree because the foliage is lost near the end of the season.

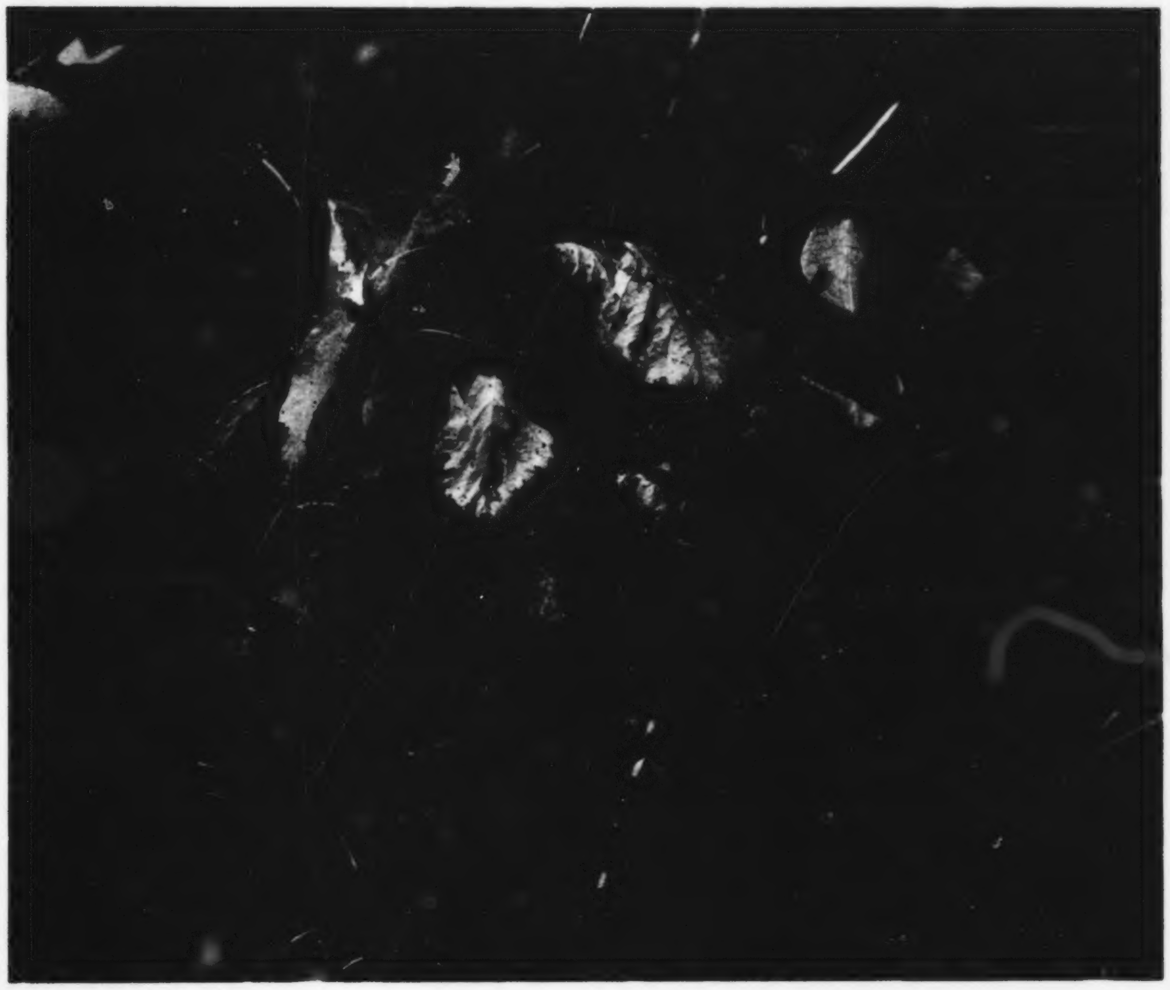
Look For —

- Large webs (up to 3 feet long) spun over the foliage in late summer, sometimes covering entire trees.
- Hairy larvae with yellow and black bodies in the web.

Biology — There may be from one generation in the North to four generations in the South. The female moths lay eggs in clusters on the undersides of leaves. Larvae feed in clusters and spin the characteristic web around the foliage to protect themselves. They pupate in bark crevices. Overwintering is in the pupal stage.

Monitoring — Check trees in summer for webs. Consider control only if branches die.

Control — Control generally not recommended. When there are a few webs, they can be cut and burned. If control is necessary, apply Bt (*Bacillus thuringiensis*) or a recommended chemical insecticide before larvae form webs.



Nest of fall webworm.

Larval cluster of fall webworms.

Cottonwood Leaf Beetle (*Chrysomela scripta*)

Importance — Adults and larvae defoliate young trees in nurseries, plantings, and natural stands. Heavy and repeated defoliation reduces growth, and deforms and kills young trees.

Look For —

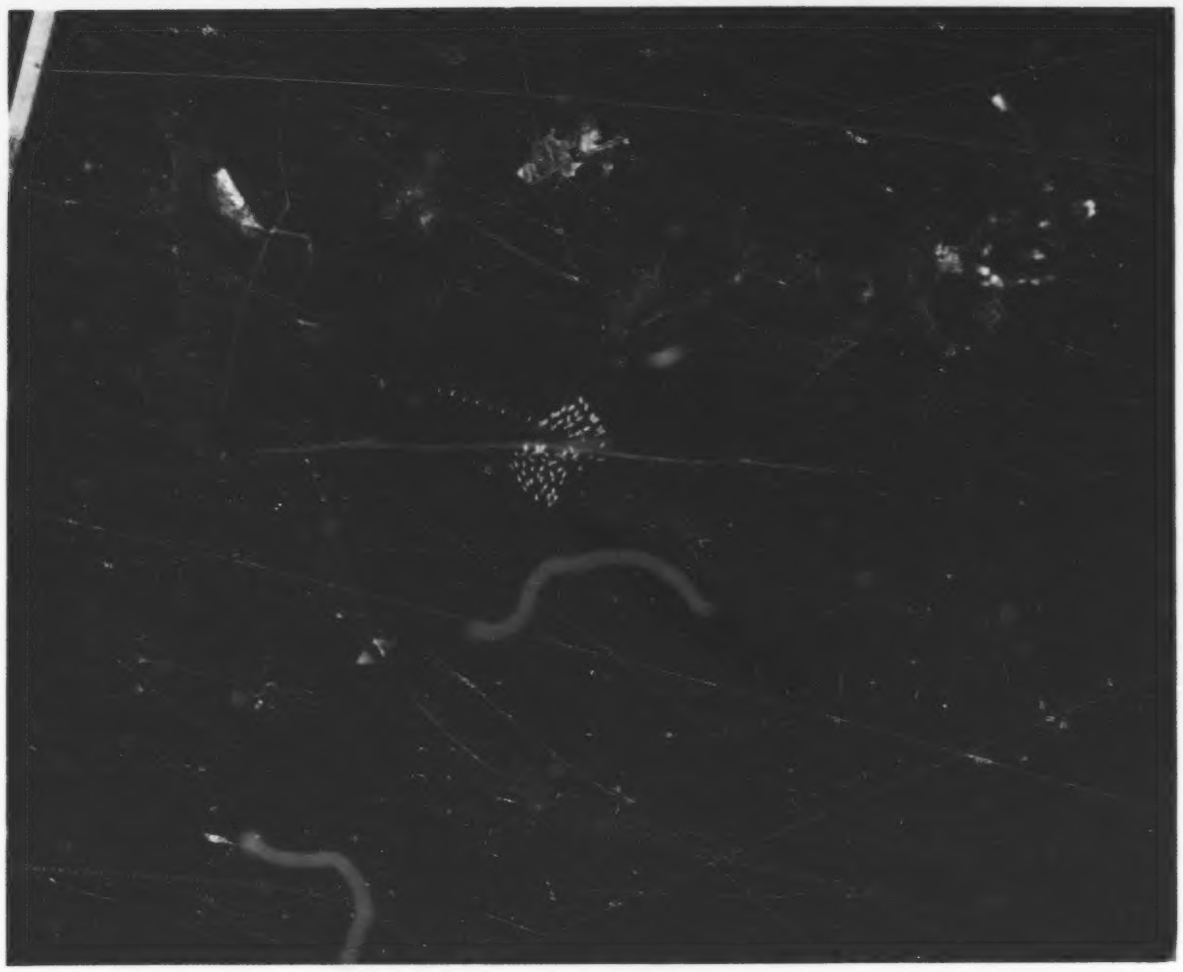
- Sparse or ragged foliage partly consumed. Entire trees may be defoliated so that only leaf petioles and large veins remain.
- Yellow egg clusters on the undersides of leaves.
- Dark brown and white larvae (one-fourth to one-half inch long) in groups on the leaves.
- Black-spotted ovoid beetles on the leaves.

Biology — The number of generations each year ranges from seven in the South to three in the North. All life stages can be found throughout the growing season. The adult female beetles lay eggs in clusters on the undersides of leaves. Newly hatched larvae feed in clusters and skeletonize the leaves; older larvae consume the entire leaf except for the midrib and large veins. Large populations of larvae will also feed on growing shoots and buds. The adult beetles also feed on leaves as well as on the tender bark at the tips of twigs. Adults of the last generation overwinter under leaf debris or in clumps of weeds.

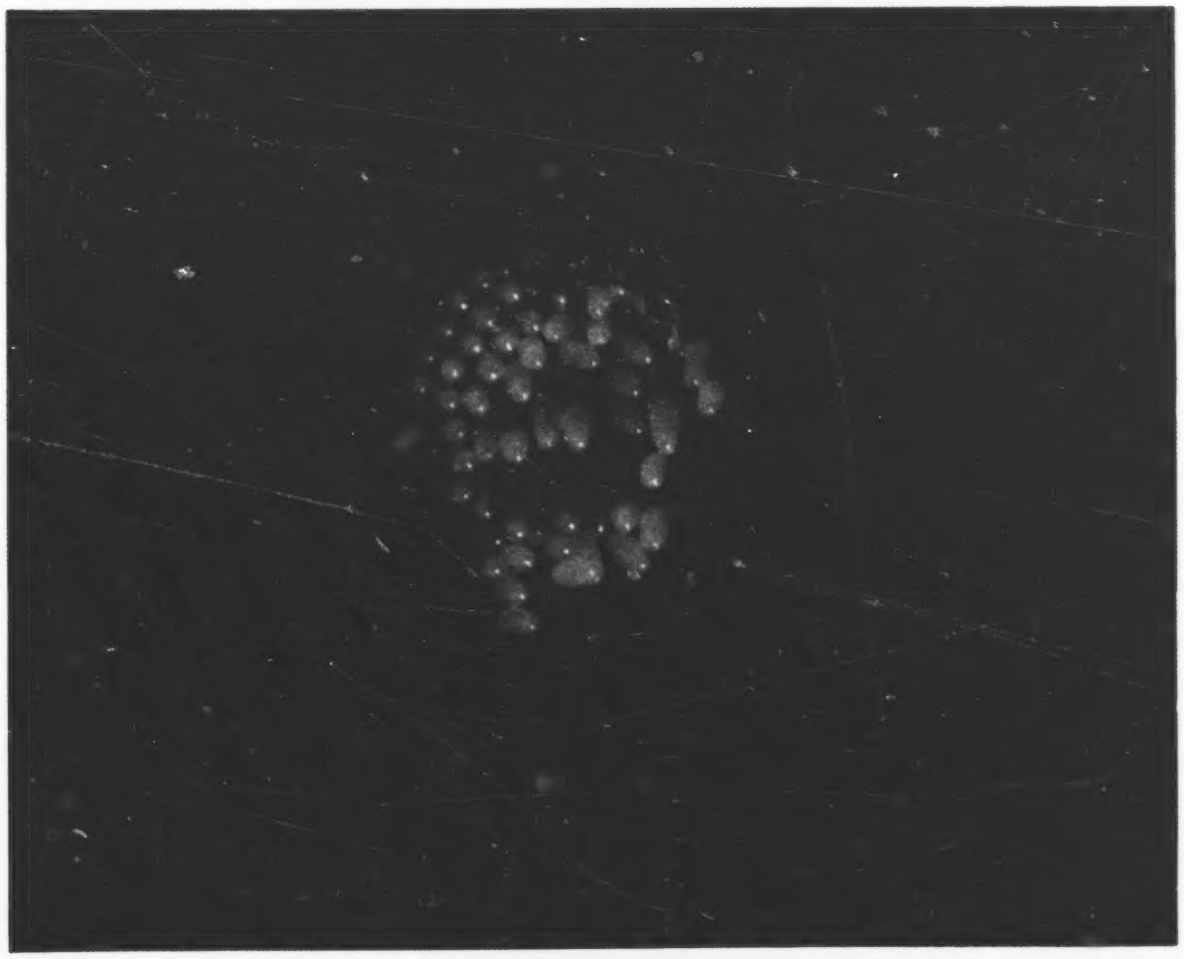
Monitoring — Inspect whips or trees for adult beetles soon after weather warms and thereafter for all life stages. Examine 50 whips of each clone in the nursery; when any clone averages one or two beetles per whip, consider treatment with an approved or registered insecticide. In plantations, treat when trees are 20 percent defoliated.

Control —

- In heavily infested areas, spray trees thoroughly with an insecticide recommended for leaf beetles. Repeat if populations rise and defoliation continues.
- Plant resistant clones.



Leaf damaged by cottonwood leaf beetle.



Egg cluster of cottonwood leaf beetle.

For Additional Information —

Caldbeck, Elaine; McNabb, Harold S., Jr.; Hart, Elwood R. 1978. Poplar clonal preferences of the cottonwood leaf beetle. Journal of Economic Entomology. 71: 518–520.

Harrell, M. D.; Benjamin, D. M.; Berbee, J. G.; Burkot, T. R. 1981. Evaluation of adult cottonwood leaf beetle, *Chrysomela scripta* (Coleoptera: Chrysomelidae), feeding preference for hybrid poplars. The Great Lakes Entomologist. 14: 181–184.

Neel, W. W.; Morris, R. C.; Head, R. B. 1976. Biology and natural control of the cottonwood leaf beetle, *Chrysomela scripta* (Fab.) (Coleoptera: Chrysomelidae). In: Thielges, Bart A.; Land, Samuel B., Jr., eds. Proceedings, symposium on eastern cottonwood and related species; 1976 September 28–October 2; Baton Rouge, LA. Baton Rouge, LA: Louisiana State University: 264–271.

Oliveria, F. L.; Cooper, D. T. 1977. Tolerance of cottonwood to damage by cottonwood leaf beetle. In: Proceedings, Southern forest tree improvement conference; 1977 June 14–16; Gainesville, FL. Macon, GA: U.S. Department of Agriculture, Forest Service, Eastern Tree Seed Laboratory; 14: 213–217.

Cottonwood leaf beetle larvae.

Adult cottonwood leaf beetle.

Variegated Cutworm (*Peridroma saucia*)

Importance — The larvae occasionally kill emerging nursery stock and cuttings planted in old farm fields.

Look For —

- Seedlings or cuttings severed near the ground line.
- Missing foliage or foliage partly buried near the seedling or cutting.
- Pale gray to dark brown larvae up to 1½ inches long. Larvae feed on the plant at night and hide in the soil near the plant during the day.

Biology — The female moth deposits eggs on stems, leaves, lower branches, and twigs. Newly hatched larvae burrow into the soil and begin to feed soon after. There may be four generations per year, but spring feeding causes the most damage.

Monitoring — Inspect young trees for damage in the spring. Search for larvae in the soil if you suspect cutworms. Control immediately if damage exceeds 10 percent.

Control —

- Apply a commercial preparation of Bt (*Bacillus thuringiensis*) to the foliage.
- Apply a chemical insecticide recommended for cutworms in the late afternoon or early evening.

New shoots injured by cutworm.

Leafcurl Midge
(*Prodiplosis morrisi*)

Importance — The larvae distort and kill newly developing terminal leaves on trees of all sizes. In nurseries, heavily injured shoot tips may die. Large trees become flat-topped.

Look For —

- Distorted, puckered, and folded leaves on terminal shoots and branches, often in distinct whorls with normal leaves in between, found throughout the growing season.
- Tiny white legless maggot-like larvae within the folded leaves.

Biology — The mosquito-like female midge deposits numerous eggs on developing shoot tips, preferring the terminals. The larvae feed on the surfaces of the expanding leaves, causing the leaves to become distorted. There may be five or more generations in a season. Each generation damages 1 to 2 whorls of leaves; and because there is a short period between generations, normal leaves alternate with damaged leaves. Larvae of the last generation overwinter in the soil beneath the trees.

Monitoring — Inspect trees throughout the growing season for one or more whorls of distorted and folded leaves. If 50 percent of the trees are attacked in a nursery, treat the infested area.

Control —

- Till soil in nursery in spring to reduce emerging adults.
- Apply a systemic insecticide recommended for leaf feeding insects.

For Additional Information —

Morris, Robert C. 1981. A new pest of poplars. Pest Control Rep. 13. Maple, ON: Pest Control Section, Ministry of Natural Resources. 7 p.

Injury caused by leafcurl midge.

Poplar Tentmaker (*Clostera inclusa*)

Importance — Because of their leaf-feeding habits, the larvae of this insect may completely defoliate young trees and nursery stock. Attacked trees are usually stunted, and those in plantations may become overtopped by weeds. The poplar tentmaker is found in Southern Canada and from New England to Georgia and Colorado.

Look For —

- A tent consisting of dense webbing over a few leaves.
- Dark brown caterpillar about 1½ inches long with four yellow lines on its back and one bright yellow and several indistinct lines on each side. The larvae are inside the tent in clusters.

Biology — There is one generation in the North and two or more in the South. Adults appear in the spring (and again in summer in the South), and the females lay eggs in clusters on the undersides of leaves. In the fall, the larvae crawl to the ground, pupate, and overwinter in loose cocoons in the soil.

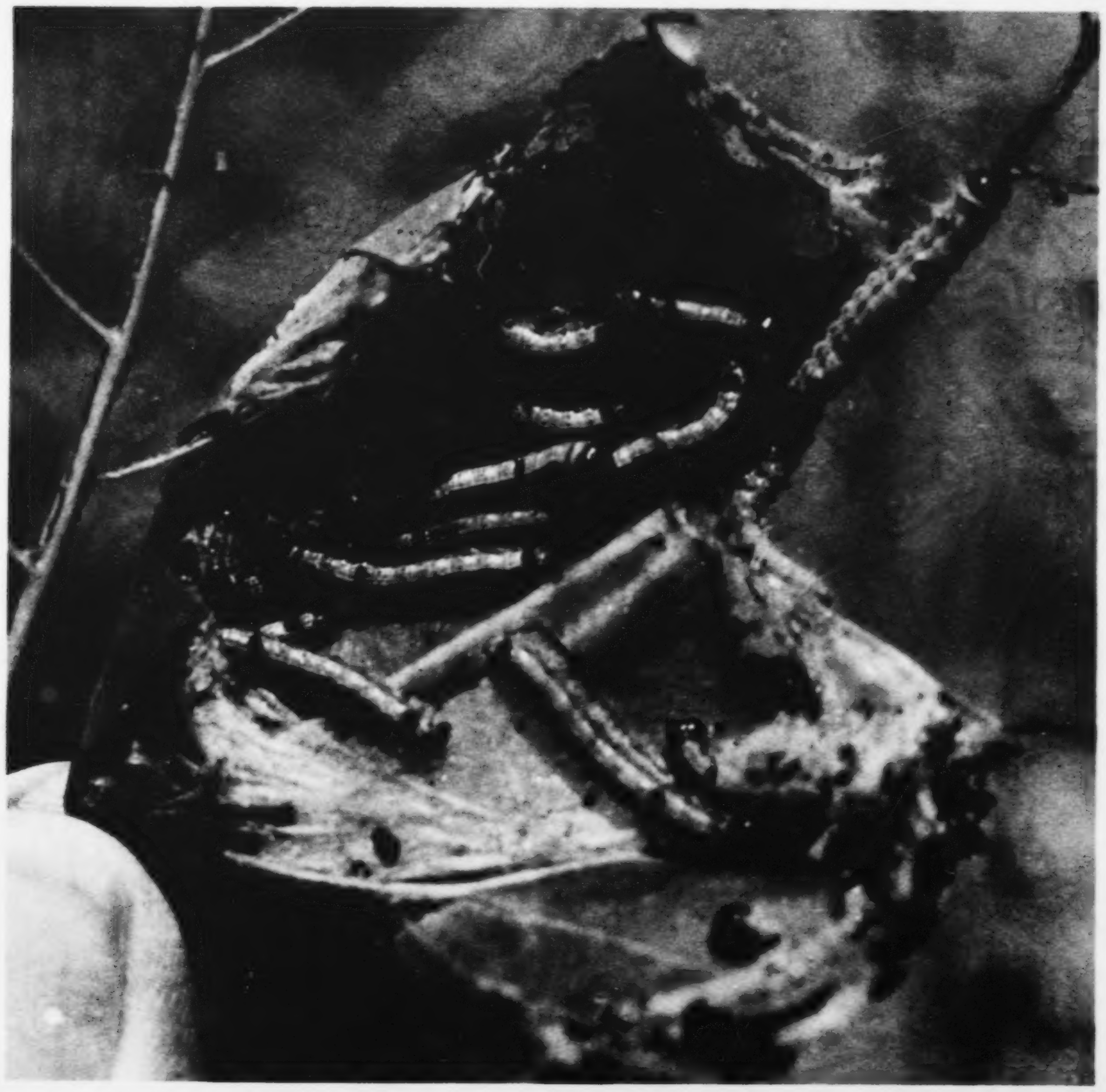
Monitoring — Check nursery or young plantings for tents. Consider control in the nursery if 5 to 10 percent of the cuttings have tents. In plantations, control only when 10 percent of the trees are fully defoliated. Note, however, that natural enemies usually control the insects in 2 or 3 years.

Control — Spray tents with Bt (*Bacillus thuringiensis*) as soon as larvae are present. An alternative is to apply a chemical insecticide recommended for defoliators shortly after the larvae emerge from the eggs (i.e., spring in the North; spring and midsummer in the South).

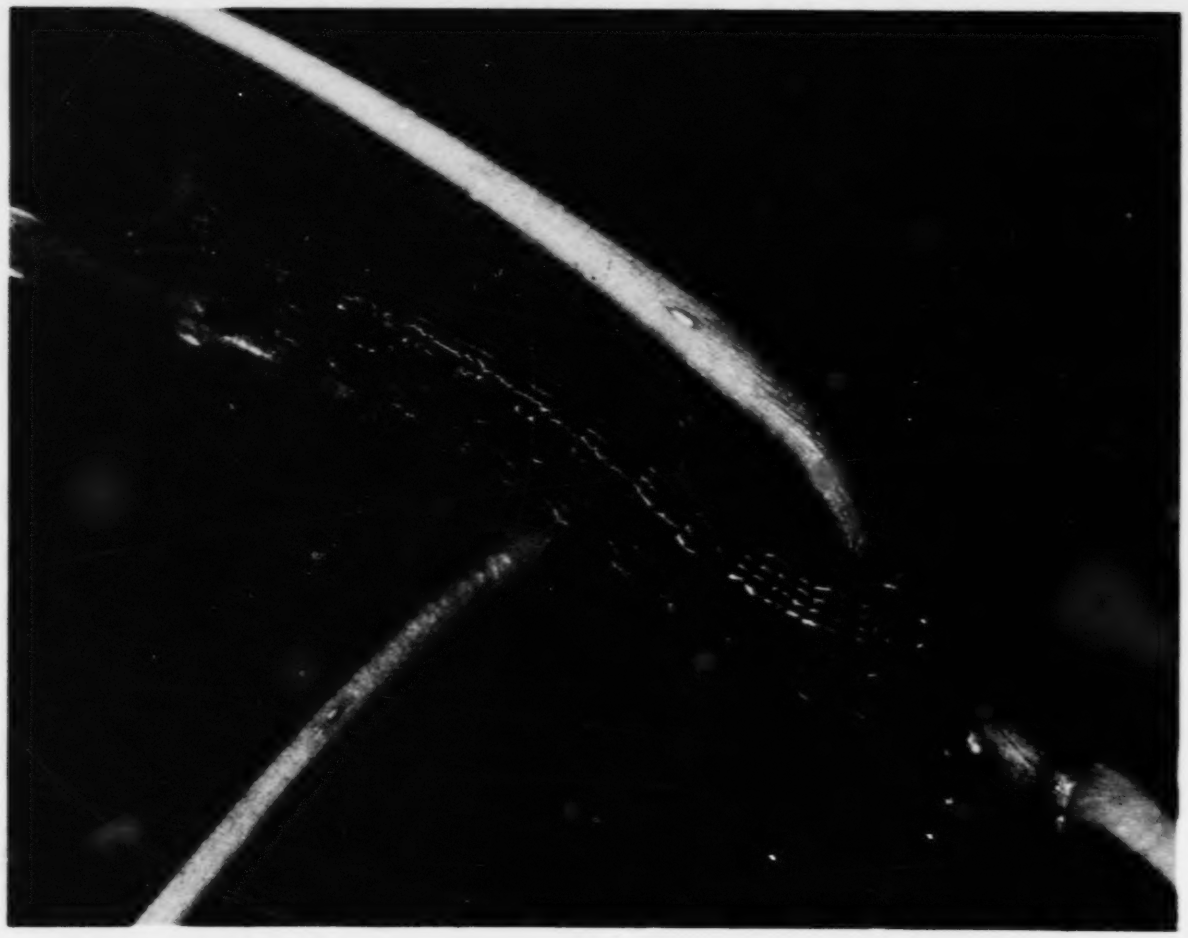
For Additional Information —

Oliveria, F. L. 1978. Poplar tent maker a serious pest of cottonwood plantations in 1977. Journal of Mississippi Academician Science (suppl.). 23: 2.

U.S. Department of Agriculture, Forest Service. 1985. Insects of eastern forests. Misc. Publ. 1426. Washington, DC: U.S. Department of Agriculture, Forest Service. 608 p.



◀ *Cluster of young poplar tentmaker larvae.*



▶ *Larva of poplar tentmaker.*

Boring Insects

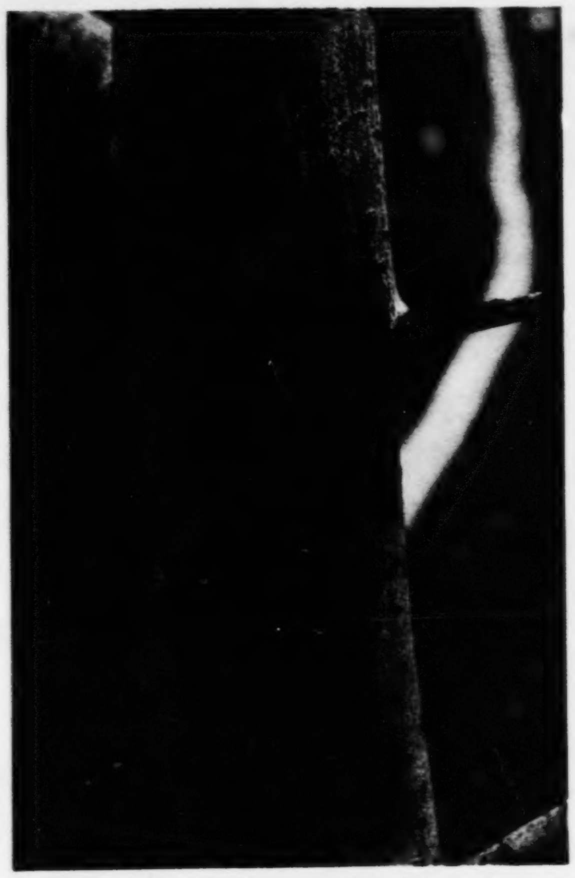
Poplar Borer (*Saperda calcarata*)

Importance — Larvae bore in the stems, roots, and branches of trees 3 years old and older. Several larvae feeding together may riddle the stem, causing the tree to weaken and break. Decay fungi entering through the galleries and woodpecker holes contribute to the tree's death. Attacks are heavier in poorly stocked and thinned stands. Sawtimber from surviving trees is greatly degraded.

Look For —

- Sap spots and sap mixed with frass oozing from small openings on the mainstem.
- Split bark at gallery entrances.
- Coarse, fibrous, frass at gallery entrances, in bark crevices, and at tree base.
- Yellow-white legless larvae up to 1¼ inches long in galleries in the wood. (Cut stem open to see this.)

Biology — The grayish-blue spotted female beetle lays eggs in late spring and early summer in slits chewed in the bark. Larvae bore into the stems or branches and make extensive galleries in the sapwood and heartwood. After 2 years' growth, the larvae pupate and adults exit through the former entrance hole.



Sap streak from poplar borer feeding.

Sap streak and frass of poplar borer.

Monitoring — Inspect 3-year-old or older trees for signs of boring injury. Sometimes individual trees become brood trees after repeated attacks. Consider treatment when 10 percent of sample trees are attacked.

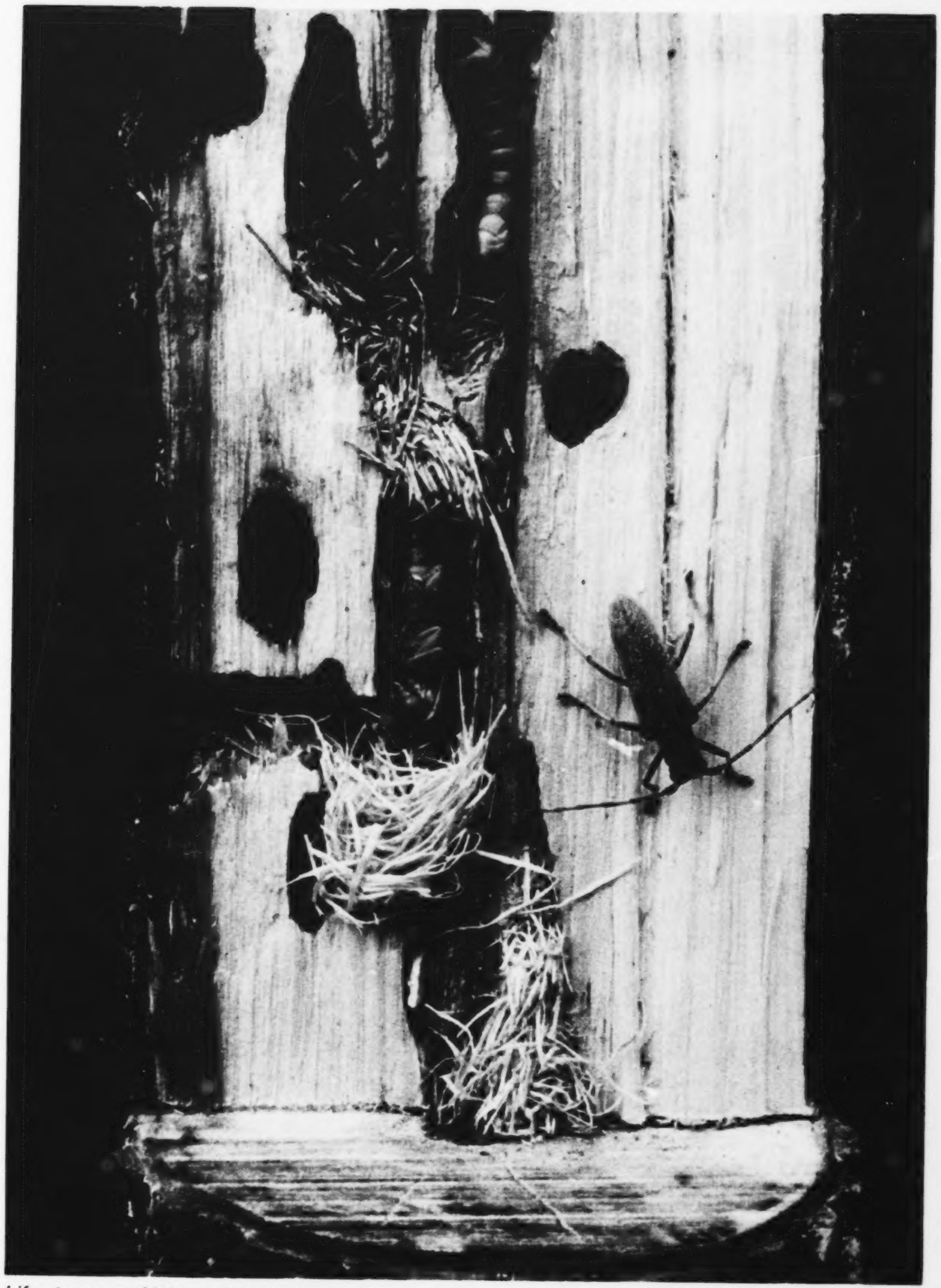
Control —

- Remove brood trees and heavily injured trees.
- Maintain well-stocked stand until harvest.
- Clearcut at harvest.
- Apply an insecticide recommended for boring insects to kill adults in spring.

For Additional Information —

Ewan, H. G. 1960. The poplar borer in relation to aspen stocking. Tech. Note 580. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Lake States Forest Experiment Station. 2 p.

U.S. Department of Agriculture, Forest Service. 1985. Insects of eastern forests. Misc. Publ. 1426. Washington, DC: U.S. Department of Agriculture, Forest Service. 608 p.



Life stages and injury of poplar borer.

Poplar-and-Willow Borer (*Cryptorhynchus lapathi*)

Importance — Larvae of this weevil riddle the stems of young trees in plantations throughout north-central North America. Complete girdling kills the tree above the injury, forcing the tree to resprout multiple stems. Trees weakened by larvae may break.

Look For —

- Upper crown or the whole tree broken over or dead.
- Coarse, fibrous wood shavings on trunk either plugging or adjacent to a hole (up to one-fourth inch in the bark; the area below the hole may be moist from exuding sap).
- White grub-like larvae, pupae, or black and white weevils (up to one-third inch long) in galleries in the wood. (Saw the injured portion of the stem longitudinally to see this.)

Biology — Adults emerge from overwintering in the wood in spring, and soon afterward the female lays eggs in the stems in slits chewed into the bark. Young larvae first bore into the cambium around the stem, but as they grow they tunnel into the wood. When fully grown, they pupate in enlarged galleries in the stem. Some

Injury caused by poplar-and-willow borer.

Wood shavings from poplar-and-willow borer gallery.

pupae transform to adults that emerge in fall and lay more eggs; others overwinter and emerge as adults in the spring.

Monitoring — Inspect trees 2 years or older that are more than 1 inch in basal diameter. Begin in late spring to look for evidence of insect boring. Consider control if 10 percent of the trees are injured or if 1 to 2 percent of the trees die or break over.

Control —

- In heavily infested areas, apply an insecticide recommended for wood-boring insects. Drench the main stem in late March or early April just before adults emerge. Repeat in July to kill summer-emerging adults.
- Avoid planting trees adjacent to heavily infested poplar, willow, or alder stands.
- Plant resistant clones.
- After harvest, remove and destroy any infested material to keep insects from reinfesting coppice or new planting stock.

For Additional Information —

Furniss, Malcolm M. 1972. Poplar-and-willow borer. For. Pest Leafl. 121. Washington, DC: U.S. Department of Agriculture, Forest Service. 5 p.

Harris, John W. E.; Coppel, Harry C. 1967. The poplar-and-willow borer. *Sternochetus (= Cryptorhynchus) lapathi* (Coleoptera:Curculionidae), in British Columbia. Canadian Entomologist. 99: 411–418.

Smith, B. D.; Stott, K. G. 1964. The life history and behavior of the willow weevil *Cryptorhynchus lapathi* L. Annals of Applied Biology. 54: 141–151.

Larva of poplar-and-willow borer.

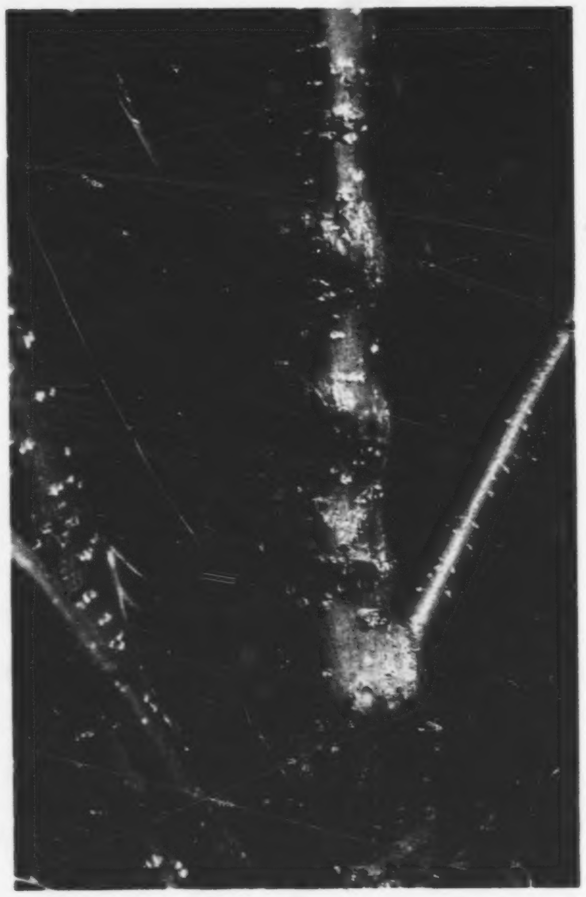
Poplar Root Girdler (*Agrilus horni*)

Importance — The larvae girdle stems by feeding particularly in sparsely stocked stands in northeastern North America. Young trees usually die from only a few larval attacks.

Look For —

- Dead or dying trees.
- Larval galleries at the tree base that appear as swollen areas encircling and forming a helix around the stem.
- Irregular larval galleries with tightly packed excrement on the wood surface. (Remove bark to see these.)

Biology — After the female beetle lays eggs on the bark at the base of the tree in spring, the emerging larvae tunnel into the stem and roots and feed in the cambium. The life cycle lasts 2 years.



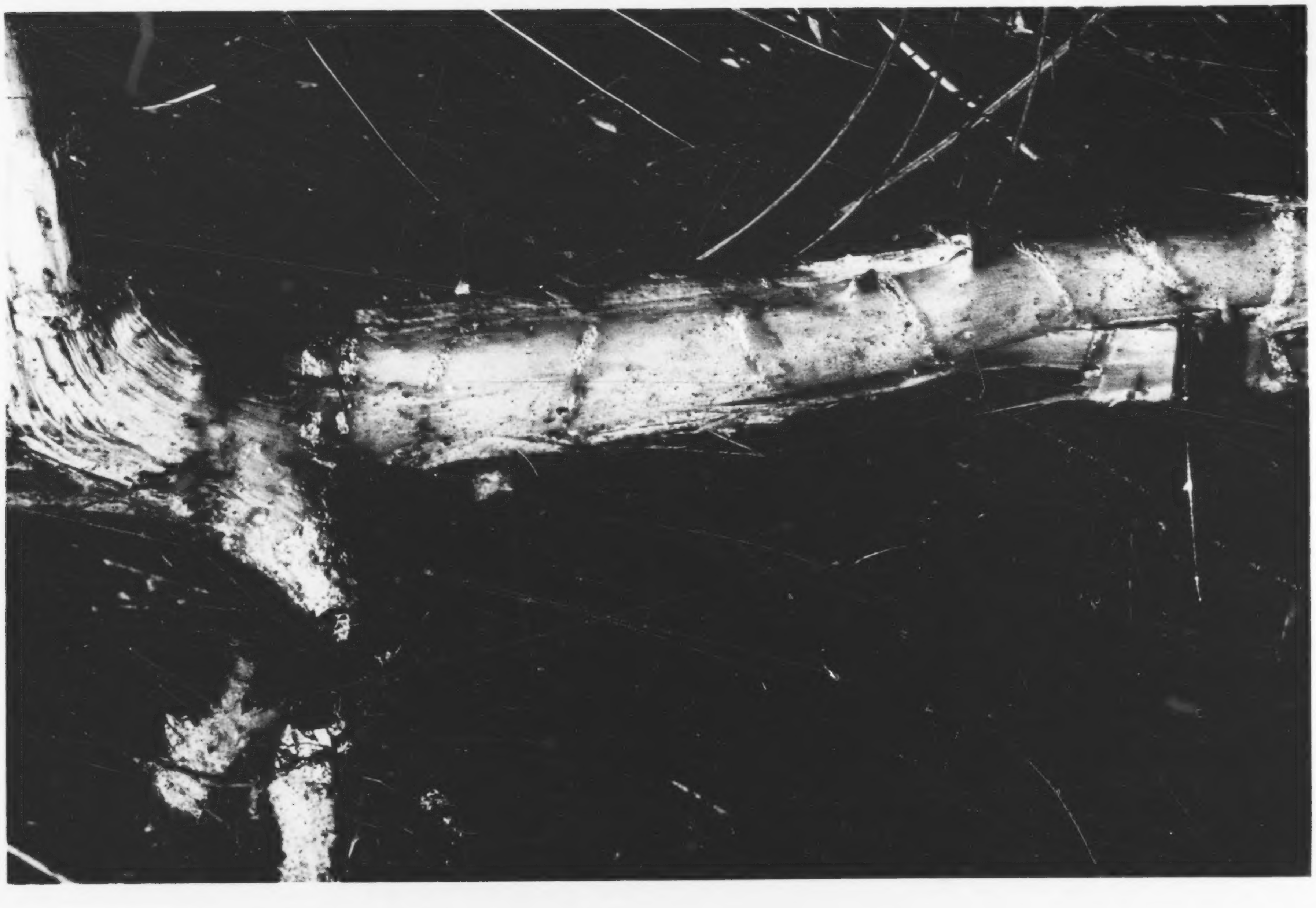
Monitoring — Inspect young trees (2 to 6 inches in diameter) for signs of injury. An occasional infected tree is usually not a cause for concern. If 10 percent of the trees become infested, treat the stand.

Control —

- Maintain healthy trees and full stocking.
- Cut and destroy infested trees.
- Apply an insecticide recommended for wood-boring insects to the base of the tree to control adults.

◀
Poplar root girdler injury.

Galleries made by poplar root girdler. ▼



Bronze Poplar Borer (*Agrilus liragus*)

Importance — The larvae girdle stems by feeding under the bark. Stems that are weakened or dying from other causes are particularly susceptible.

Look For —

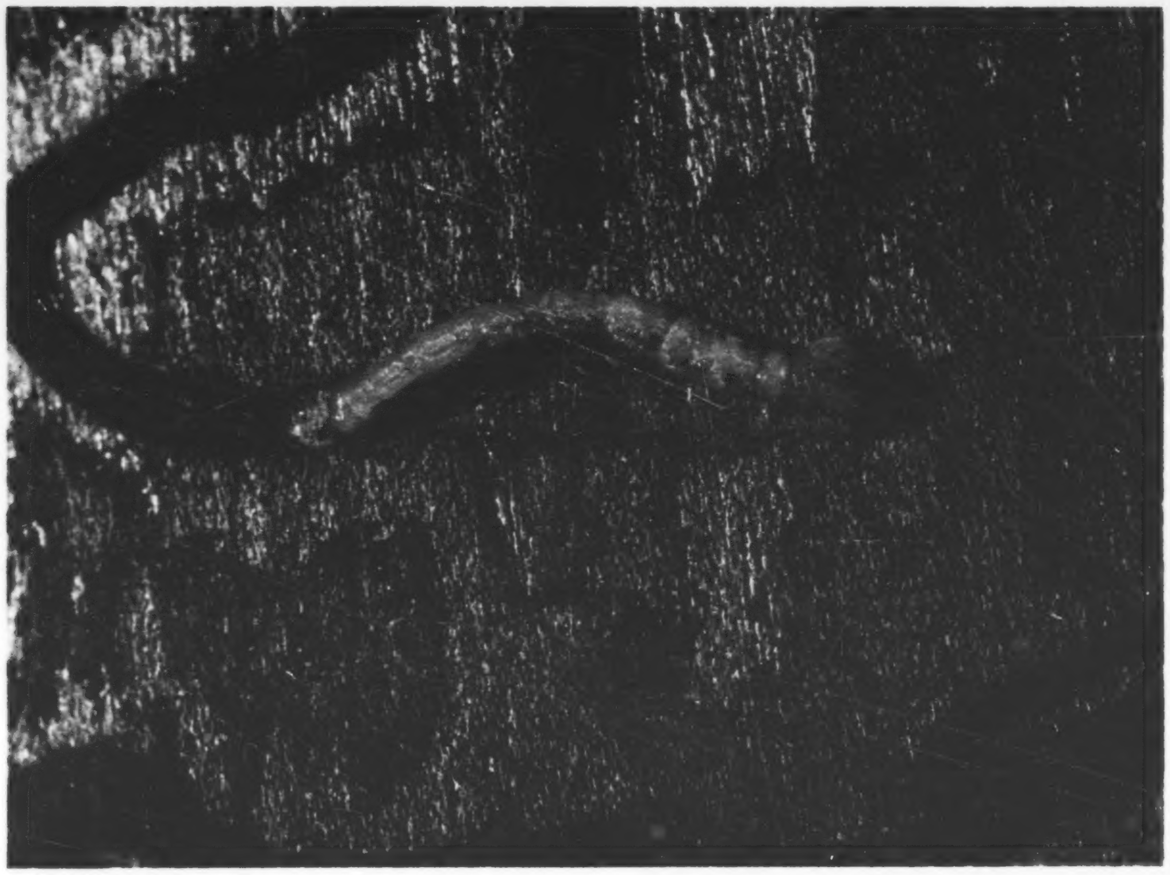
- Dead or dying trees.
- D-shaped holes on the surface of the bark of the branches and stems.
- Zig-zag galleries on the wood surface of the branches and stems. (You will need to remove some bark with a knife to see these.)

Biology — Females lay eggs in bark crevices throughout the summer. Emerging larvae tunnel into the cambium of the branches and stem. The life cycle extends over two winters.

Monitoring — Inspect medium-age trees for signs of injury. If 10 percent of the trees become infested, treat or harvest the stand.

Control —

- Maintain healthy trees, fertilize, and water if possible.
- Cut and destroy infested trees.
- Apply a pesticide recommended for wood-boring insects to the stems and branches in early summer to control adults.



Bronze poplar borer injury.

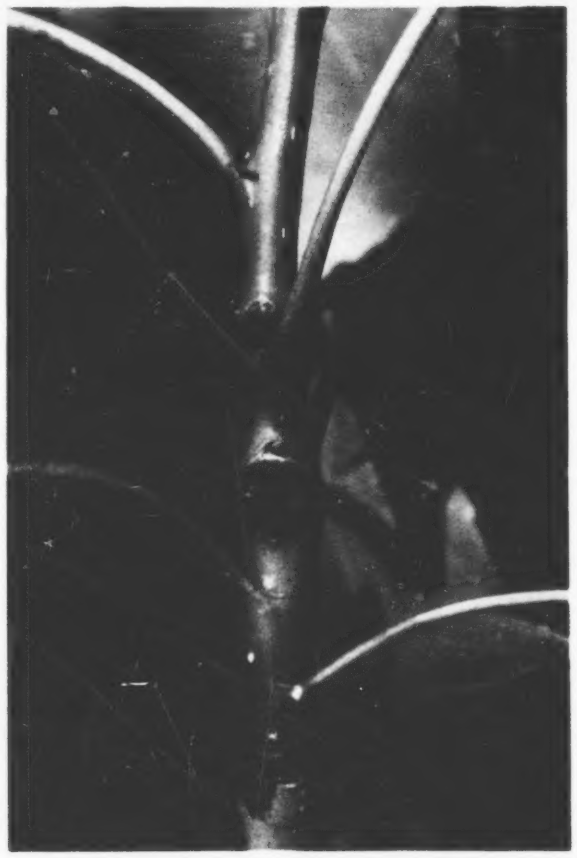
Cottonwood Twig Borer (*Gypsonoma haimbachiana*)

Importance — Larvae bore into newly developed shoots, killing shoots and causing irregular growth. Heavily injured trees become deformed, bushy, and of little value. This pest is found throughout eastern North America but is more serious in the South where there are multiple generations.

Look For —

- Dead or dying new shoots.
- Small patches of brown, webbed insect excrement at basal end of new shoots. Shoots may be swollen and/or stunted.
- Stub of shoot tips overgrown by new growth forming a fork.
- Larvae up to one-half inch long located inside injured shoots.

Biology — This insect has from one generation in the North to five in the South. The adult moths emerge from cocoons in spring; soon after the females lay eggs singly or in small clusters on the upper leaf surface. Young larvae feed on the leaves and veins until they molt, then they move to the base of developing leaves and tunnel into the tender shoots. Full-grown larvae move down the tree and spin cocoons



Injury caused by cottonwood twig borer.

in bark crevices or in the litter under the trees. In warmer areas the borer produces more generations, and larvae of the last generation overwinter in small silken shelters on the shoots. These larvae move to new shoots in spring and complete their growth.

Monitoring — Inspect new shoots at regular intervals from early spring until late summer for boring activity. When you discover borings, examine 20 to 30 whips in each clone in the nursery. If 20 percent of the stock in a clone is infested, apply treatment. In plantations treat when 25 percent of new shoots become infested.

Control —

- If practical, clip off and destroy infested shoots.
- Apply an insecticide recommended for boring insects, and time spray to kill larvae before they bore into shoots.
- Plant resistant clones of *Populus*.

For Additional Information —

Morris, Robert C. 1967. Biology of *Gypsonoma haimbachiana* (Lepidoptera: Olethreutidae), a twig borer of eastern cottonwood. Annals of the Entomological Society of America. 60: 423–427.

Southern Clearwing Moth (*Paranthrene tabaniformis*)

Importance — The larvae attack the terminal shoot of young *Populus*. Weakened terminals may break over, causing malformed or bushy trees. Borer holes are infection courts for pathogens.

Look For —

- Sap flow from stem about 12 to 36 inches below the tree tip.
- Swollen stem or broken over terminal.
- White to pinkish larvae with brown heads about 1 to 1½ inches long inside stem below terminal.

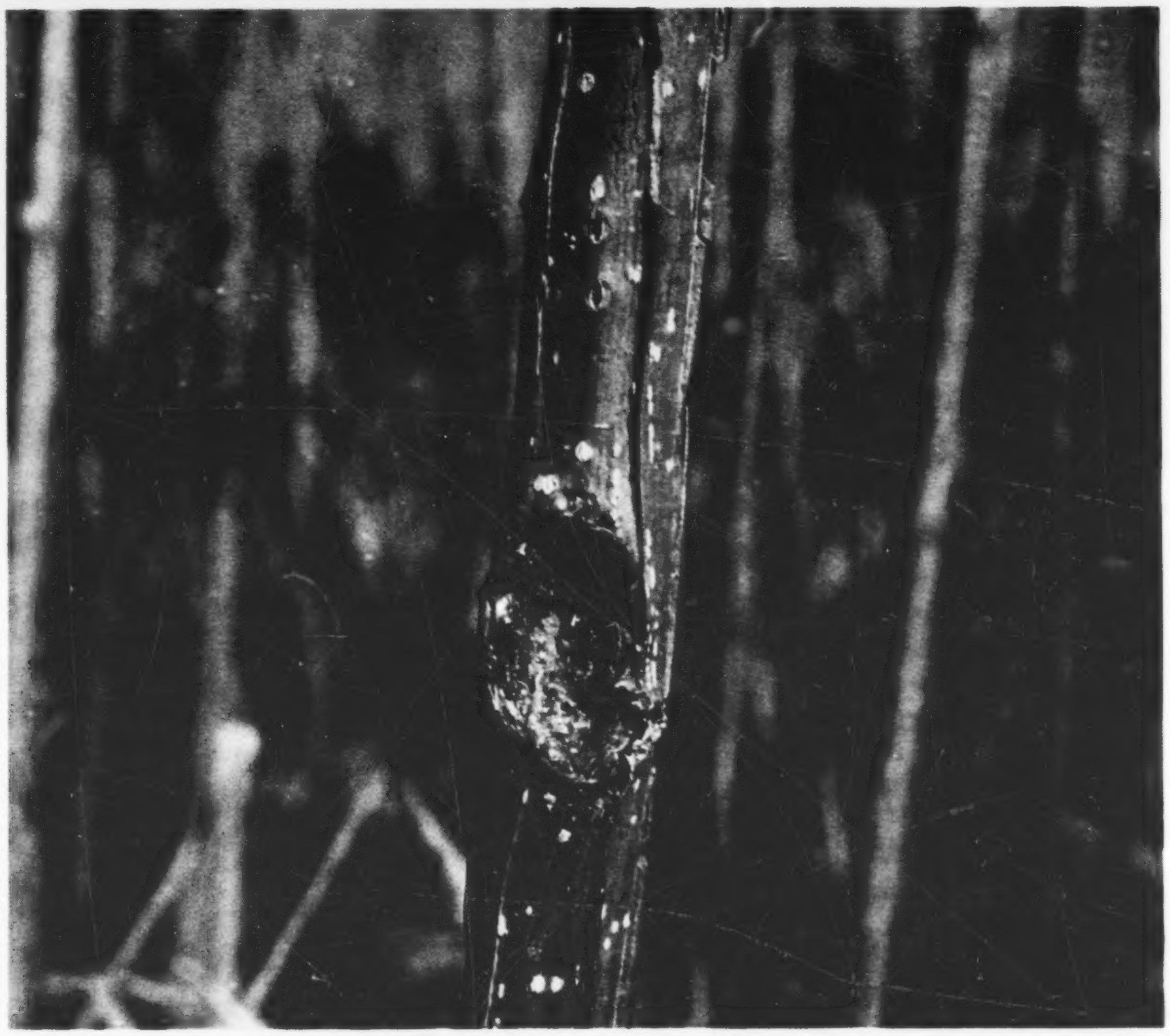
Biology — Adult females lay eggs in the bark crevices on the upper stem. Larvae hatch and tunnel in the main stem. Larvae overwinter in the galleries and pupate in the spring. Adults emerge in April in the first generation. Second-generation adults emerge in August.

Woodpeckers often reduce populations of larvae, but they may aggravate the damage by making the shoots more attractive to the moth and adding additional sites for fungi.

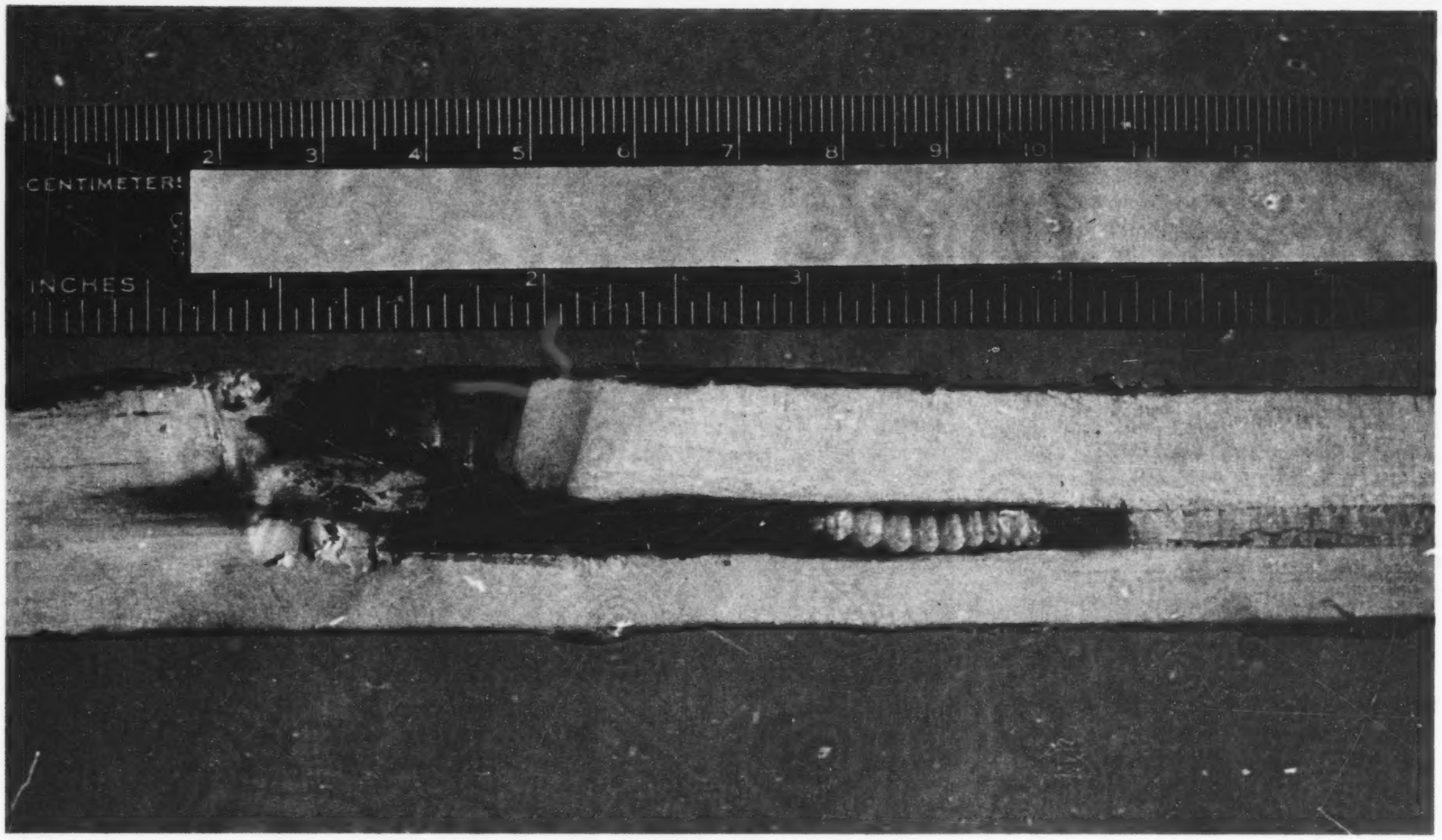
Monitoring — Inspect nurseries and young plantings for evidence of the borers. If you find a light infestation, re-examine in next 2 years to determine population status. If 5 percent of the trees show damage in the nursery or 20 pecent in plantings, consider treatment.

Control —

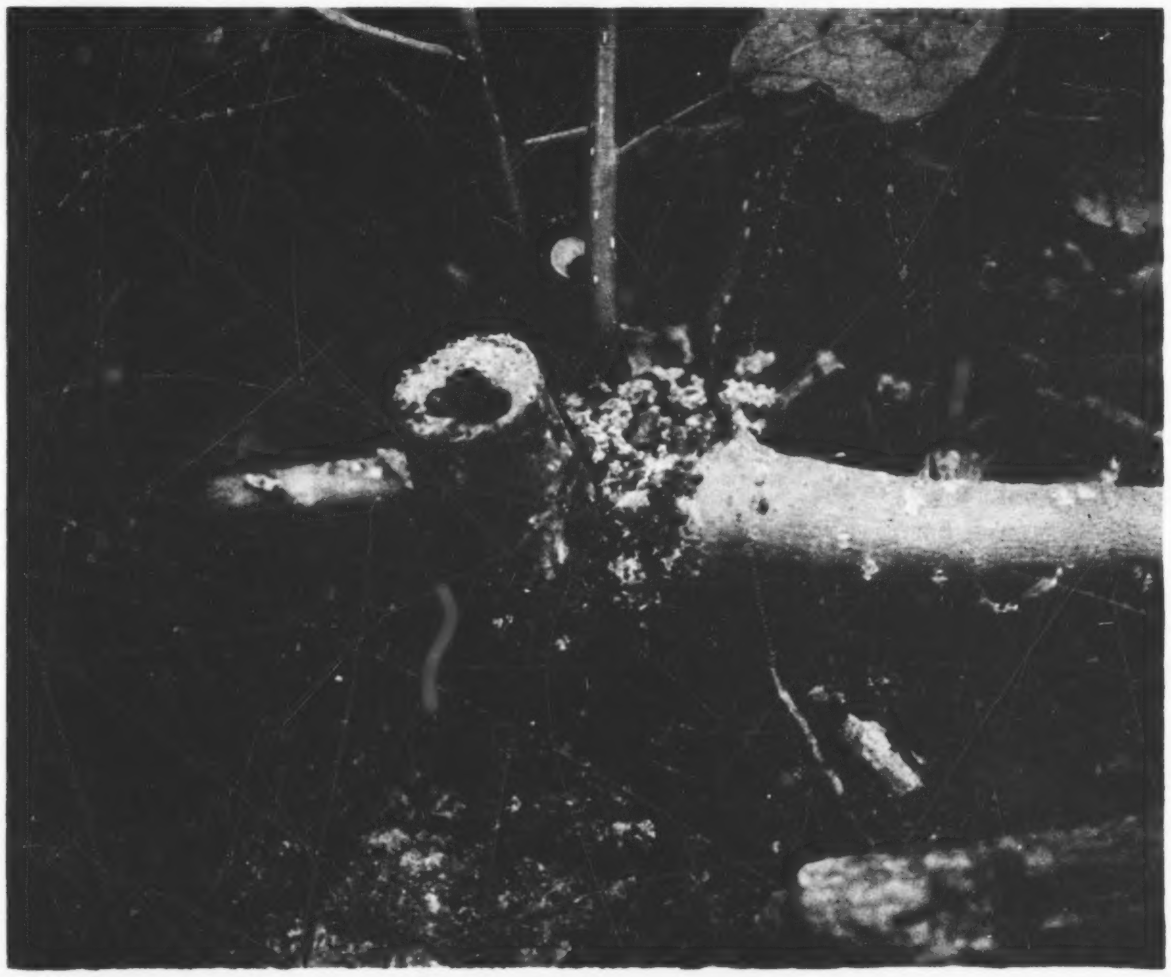
- Cut and destroy all infested material in nurseries.
- Plant uninfested cuttings.
- Apply an insecticide recommended for wood-boring insects.



Clearwing borer entrance hole.


CENTIMETERS
INCHES

Gallery and larva of clearwing borer.



Clearwing borer damage at tree base. (See text, left column, page 88.)

Poplar Clearwing Moth (*Paranthrene dollii dollii*)

Importance — The larvae attack the basal part of the stem of young *Populus* throughout the Southern United States. Stems weakened by heavy tunneling can be broken by wind. In nurseries, heavily infested stools cannot support vigorous growth from sprouts; stems often break off and die before cuttings are harvested.

Look For —

- Sap flow from base of stem.
- Stems broken over at ground.
- Pile of wood shavings near tree base.
- White to pinkish larvae with brown heads about 1 to 1½ inches long inside stem base.

(See bottom photo on page 87.)

Biology — Adult females lay eggs in the bark crevices near the stem base. Larvae hatch and tunnel in the root collar and lower stem. Larvae overwinter in the galleries and pupate in the spring. Adults emerge in April in the first generation. Second-generation adults emerge in August.

Monitoring — Inspect nurseries and young plantings for evidence of the borer. If you find damage on 5 percent of stools in nurseries or 20 percent of young trees in plantations, consider treatment.

Control —

- Rogue out and destroy all infested stools in the nursery.
- Plant uninfested cuttings.
- Apply an insecticide recommended for wood-boring insects.

Branch Borers (*Oberea schaumii* and *O. delongi*)

Importance — The larvae of these two branch borers attack young *Populus* stems and branches. Their tunneling breaks infested stems or branches. Heavily infested stems become crooked and forked, reducing commercial value.

Look For —

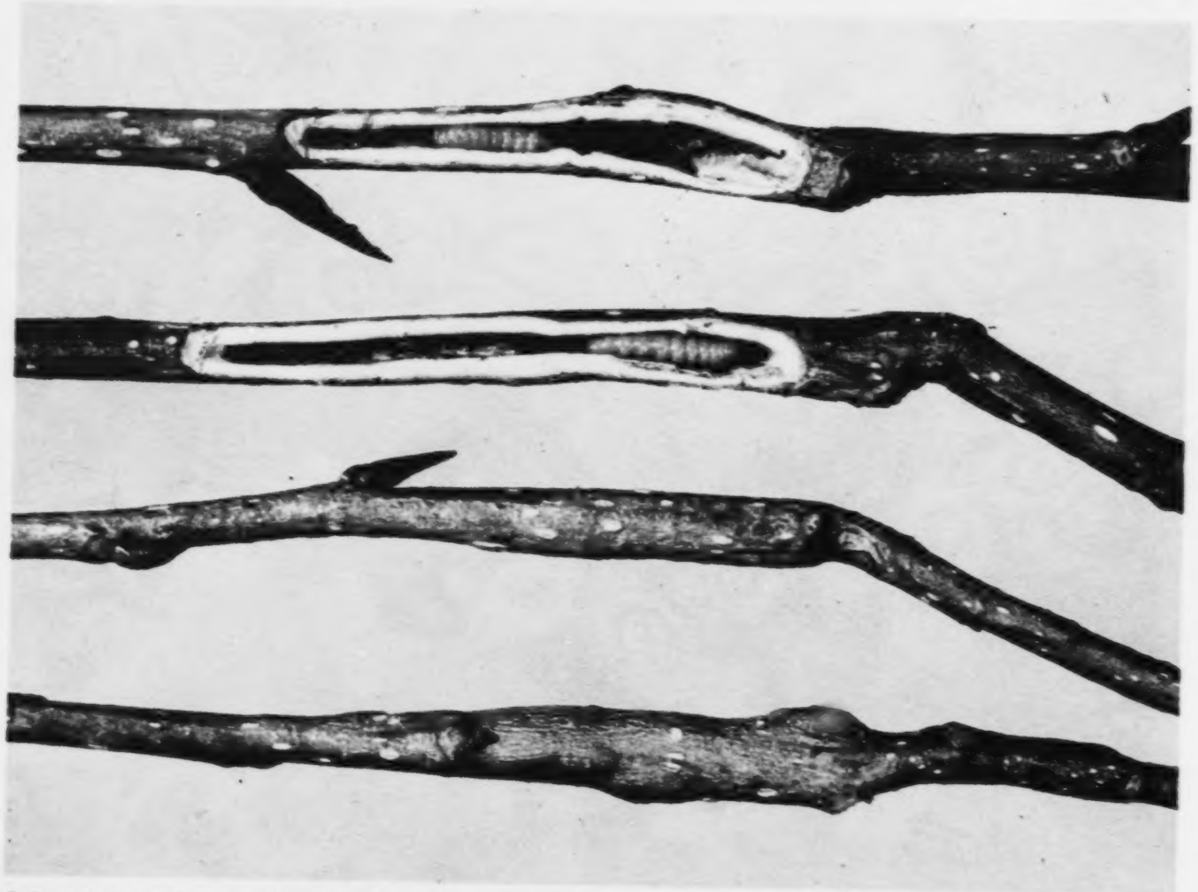
- Swollen or crooked stems.
- Entrance holes with frass protruding from the holes.
- Yellowish-white larvae ½ to 1 inch long in the pith of the branch or stem.
- Elongate longhorned beetles that range in color from yellow to black.

Biology — The adult beetle emerges in April to early July and feeds on the midrib and veins of newly developing leaves. Eggs are deposited in niches gnawed in the bark. Larvae hatch in about 2 weeks and tunnel down the center of the stem. Pupation takes place within the gallery. The life cycle for *O. delongi* is 1 year; for *O. schaumii*, 1 to 3 years. *O. delongi* occurs mainly in the South, while *O. schaumii* is most prevalent in the North. Woodpeckers often keep these borers in check.

Monitoring — Inspect small-diameter stems and branches for swollen areas and larval tunnels. If 25 percent of a stand is infested, consider treatment.

Control —

- In the nursery, remove and destroy all culled material after harvest.
- In plantations, cut, remove, and destroy infested stems and branches.
- Apply an insecticide recommended for wood borers.



Injury to branches and larvae of branch borers.

Adult O. delongi *feeding on leaf.*

Poplar-Gall Saperda (*Saperda inornata*)

Importance — Larvae bore in the wood of immature *Populus* and cause globose galls on the stems and branches. Damage is worst to nursery whips and 1- to 3-year-old trees in plantings. Stems and branches occasionally break off or die above the gall; most trees, however, overgrow the gall. Injured trees generally recover height growth within 2 to 3 years.

Look For —

May–June:

- Egg niches (horseshoe-shaped scars) on stem or branches cut by the adult beetle.
- Gray beetle one-third to one-half inch long on foliage or stem.

All year:

- Broken over or dead tops of trees or branches above the gall.
- White larvae or pupae in the woody tissues inside the gall.
- A gall with a hole on the side will be empty.

Biology — In late spring, the female beetle lays eggs in several niches cut in the main stem and branches. Usually one larva develops in each niche and feeds on the woody tissues, boring irregular galleries under the bark. A globose gall forms around the injured area as a result of the boring. In late summer, the larva bores into the center of the gall, enlarges the gallery, and pupates there. The pupa overwinters in the gall.

Monitoring — Inspect whips and young trees for egg niches or adult beetles in early May to late June. After June, search for galls on stems and branches. If the infestation exceeds 15 percent in the nurseries, prepare to treat the following year. Plantations seldom need treatment even if more than 90 percent of trees are attacked.

Control —

- Spray nursery stool beds or rooting beds if monitoring suggests control. Use an insecticide recommended for wood-boring insects, and apply when adults begin making egg niches.

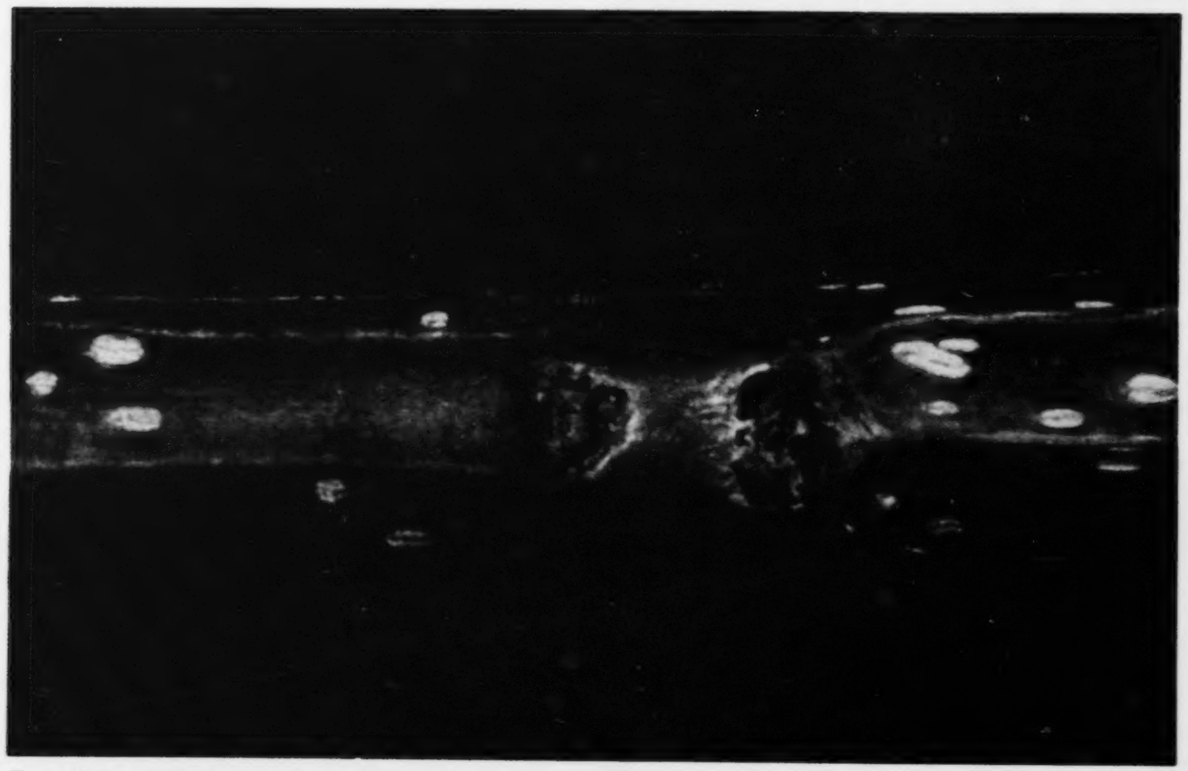
- Plant resistant clones on good sites for *Populus*.
- Prune rooted nursery stock to remove galls at harvest. Eliminate stem cuttings that have galls.

For Additional Information —

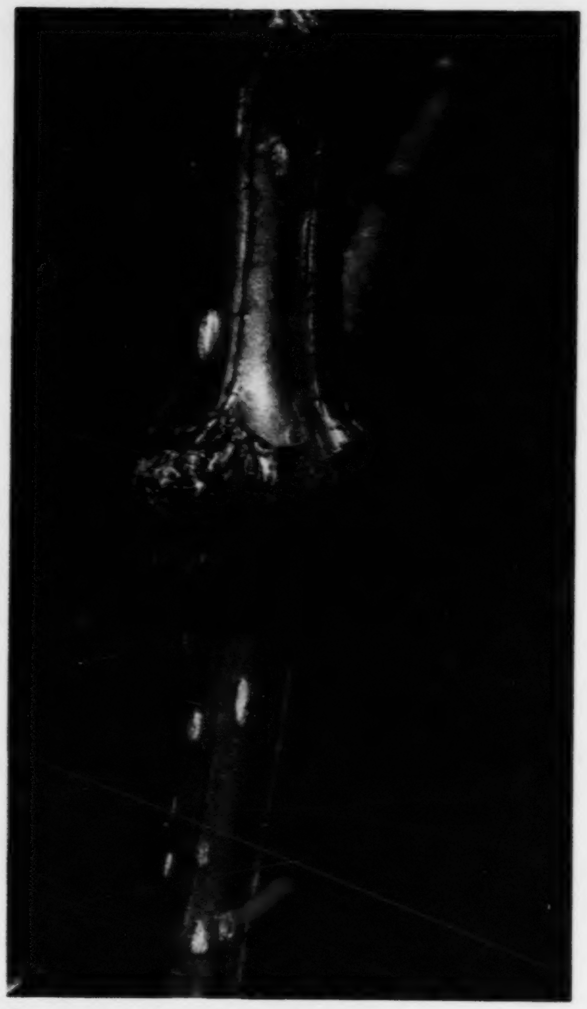
Nord, J. C.; Grimble, D. G.; Knight, F. B. 1972. Biology of *Saperda inornata [S. concolor]* (Coleoptera: Cerambycidae) in trembling aspen, *Populus tremuloides*. Annals of the Entomological Society of America. 65: 127–135.

Wilson, Louis F.; Ostry, Michael E. 1980. How to identify and prevent injury by the poplar-gall Saperda. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 6 p.

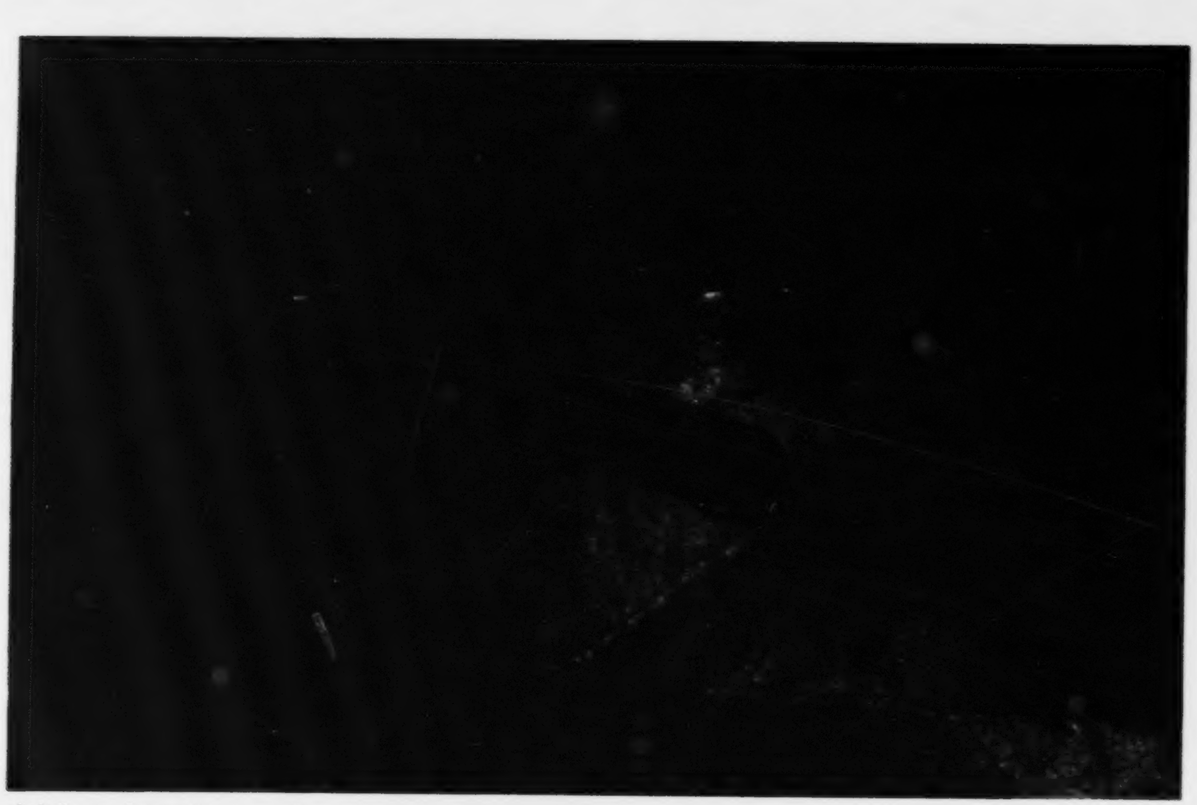
Stem breakage at gall.



Egg niche made by poplar-gall saperda.



Gall caused by poplar-gall saperda.



Adult poplar-gall saperda.

Cottonwood Borer (*Plectrodera scalator*)

Importance — Larvae attack the root collar and main roots of young trees in natural stands and plantings in the Southern United States. Structurally weakened trees may break over.

Look For —

- Stems broken at ground level.
- Light brown, fibrous frass in bark crevices near the base of the tree.
- Piles of light brown fibrous frass around the base of the tree.
- Roots with frass protruding from them.
- Legless, yellow-white larvae about 1½ inches long within the roots.
- Large, robust, longhorned beetles, 1 to 1¼ inches long, black with white cross-stripes.

Biology — Adults emerge in late spring and early summer and feed on the foliage and bark of young *Populus* shoots. Eggs are laid at or below ground level, and the larvae mine beneath the bark and into the heartwood and sapwood where they form extensive tunnels. Pupation occurs in the galleries. There is a 1 to 2 year life cycle.

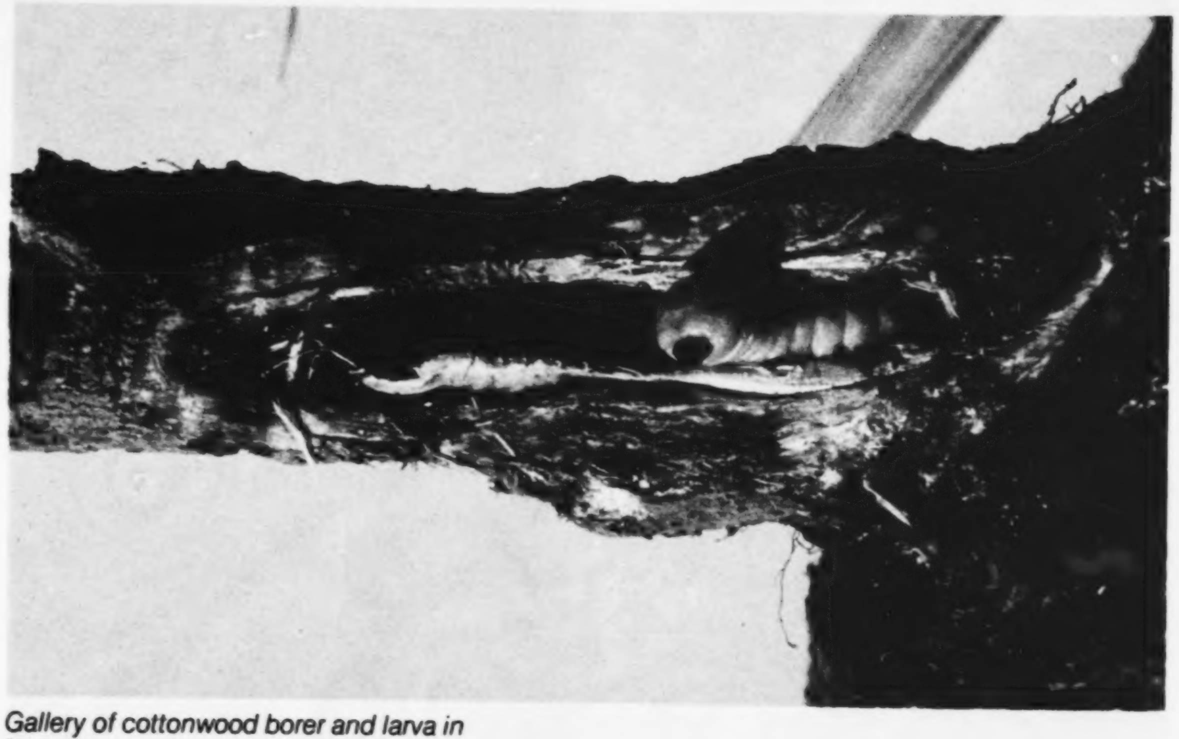
Monitoring — Inspect young trees and nursery stock for adult beetles during the growing season. Inspect the root collar area for evidence of larval boring throughout the year. Consider treatment if 10 percent of the trees are injured.

Control —

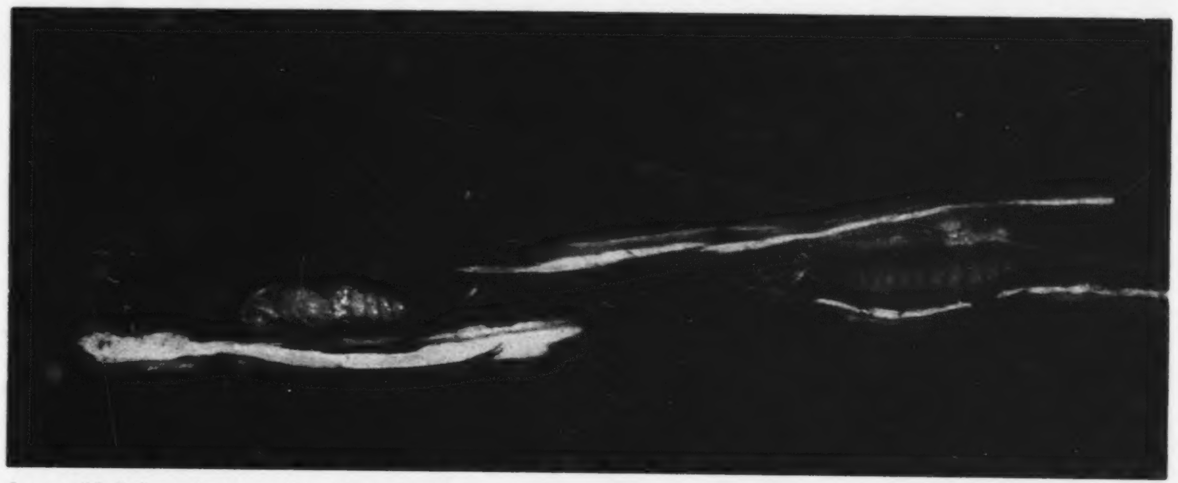
- Remove unmerchantable and brood trees.
- Remove and destroy 3-year-old or older stool beds in nurseries.
- Apply an insecticide recommended to control adult beetles feeding on the foliage.

For Additional Information —

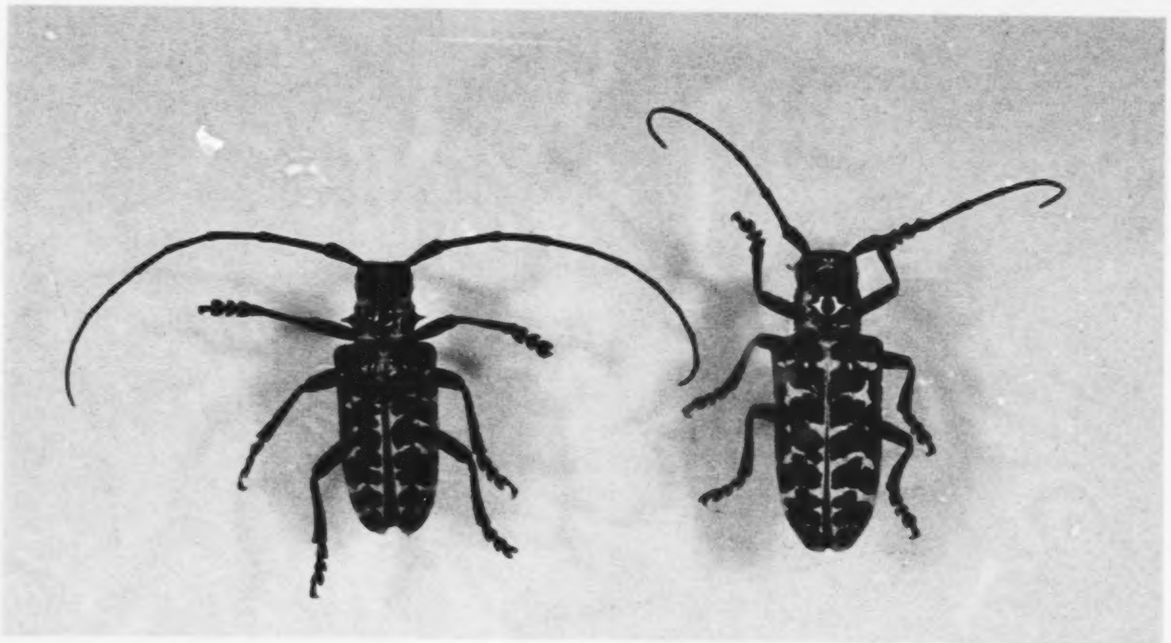
Solomon, J. D. 1979. Cottonwood borer (*Plectrodera scalator*) — a guide to its biology, damage, and control. Res. Pap. SO-157. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 10 p.



Gallery of cottonwood borer and larva in lateral root.



Larva (right) and pupa of cottonwood borer in root.



Adult cottonwood borer.

Willow Shoot Sawfly (*Janus abbreviatus*)

Importance — Young whips and suckers are damaged by the female during oviposition. Later, the larvae kill the growing tip by their tunneling. Attacked leaders die and break off, causing bushy trees.

Look For —

- Wilted shoots.
- A ring of small punctures around the tender shoot where wilting occurs.
- Green or black leaves on injured tips.
- Dead or dying stunted stems with hollow pith.
- Pinkish, apparently legless larvae or transparent cocoons within the pith.

Biology — The female sawfly girdles the stem of newly developing shoots with a ring of punctures made by her ovipositor and then lays an egg below the girdled area. The larva bores into the pith and feeds down the shoot until ready to pupate. After pupating, the adult emerges through a hole in the bark.

Monitoring — Inspect young trees and nursery stock for wilted or dying shoots during the growing season. Treat if 20 percent or more of the main stems are attacked.

Wilted shoot caused by sawfly.

Shoot damaged by sawfly.

Control —

- If practical, clip and destroy infested shoots.
- Cull infested nursery stock in summer or at harvest.
- Treat young stands and nurseries with an insecticide recommended for boring insects.

For Additional Information —

Solomon, J. D.; Randall, W. K. 1978. Biology and damage of the willow shoot sawfly in willow and cottonwood. Annals of the Entomological Society of America. 71: 654–657.

Larva of willow shoot sawfly.

Sucking Insects

Poplar Vagabond Aphid (*Mordwilkoja vagabunda*)

Importance — Colonies of feeding nymphs cause the new shoots to become distorted and produce galls rather than elongate into a branch. Heavy infestations distort entire trees. Injury is often restricted to a few trees.

Look For —

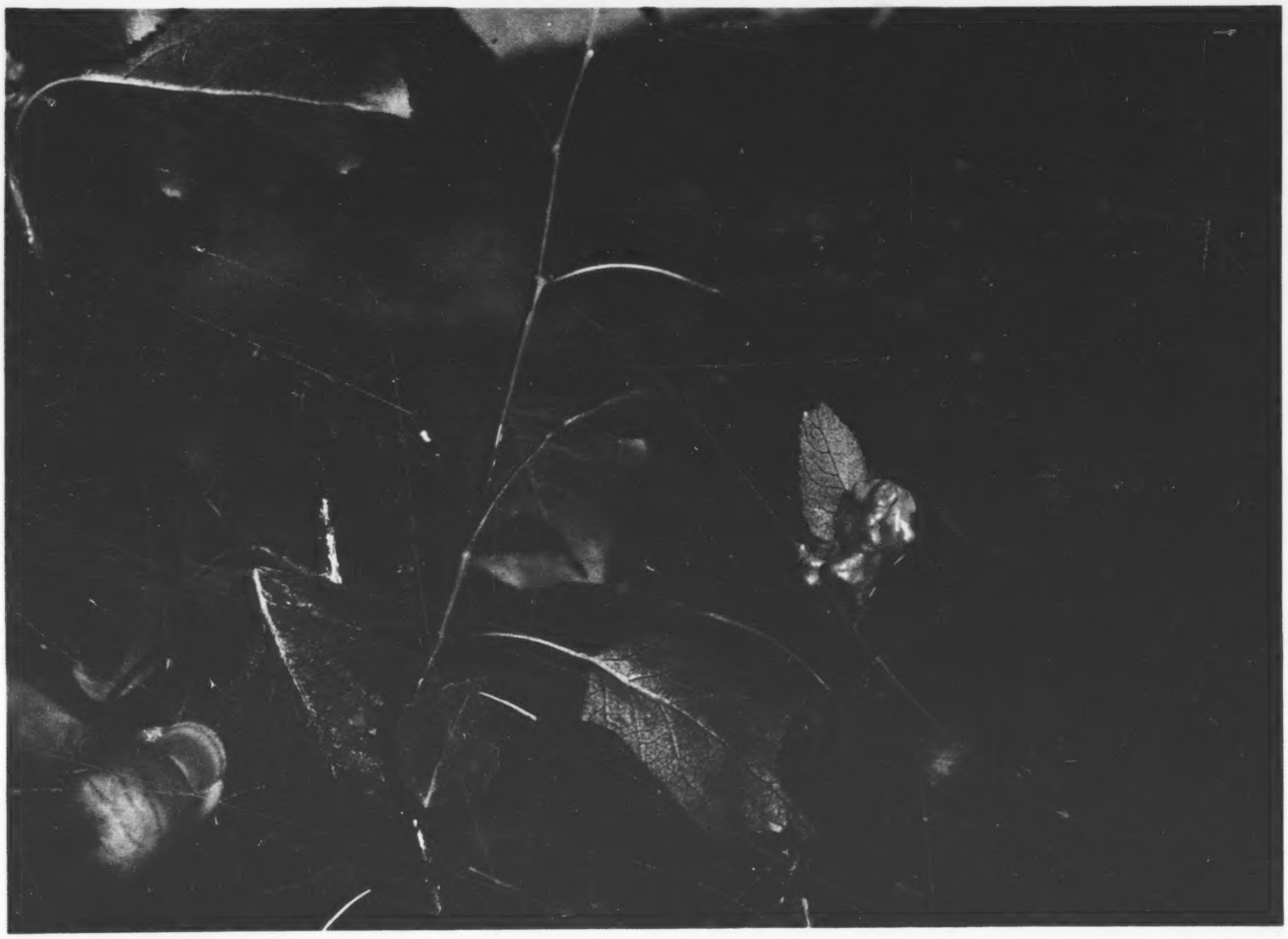
- Large convoluted green or brown galls (2 to 3 inches long) at the tips of the shoots.

Biology — The aphids feed on the growing shoots in the spring and form this unusual gall. The aphids vacate the gall in midsummer but return to it in the fall. Eggs overwinter inside the galls.

Monitoring — Inspect trees at any time for galls. Treat individual infested trees if galls become abundant.

Control —

- If practical, clip and destroy galls by hand.
- Apply an insecticide recommended for aphids in the spring to control emerging aphids.



Galls of poplar vagabond aphid.

Meadow Spittlebug
(*Philaenus spumarius*)

Importance — Nymphs and adults suck sap from the shoots of their host. They do not seriously injure poplars.

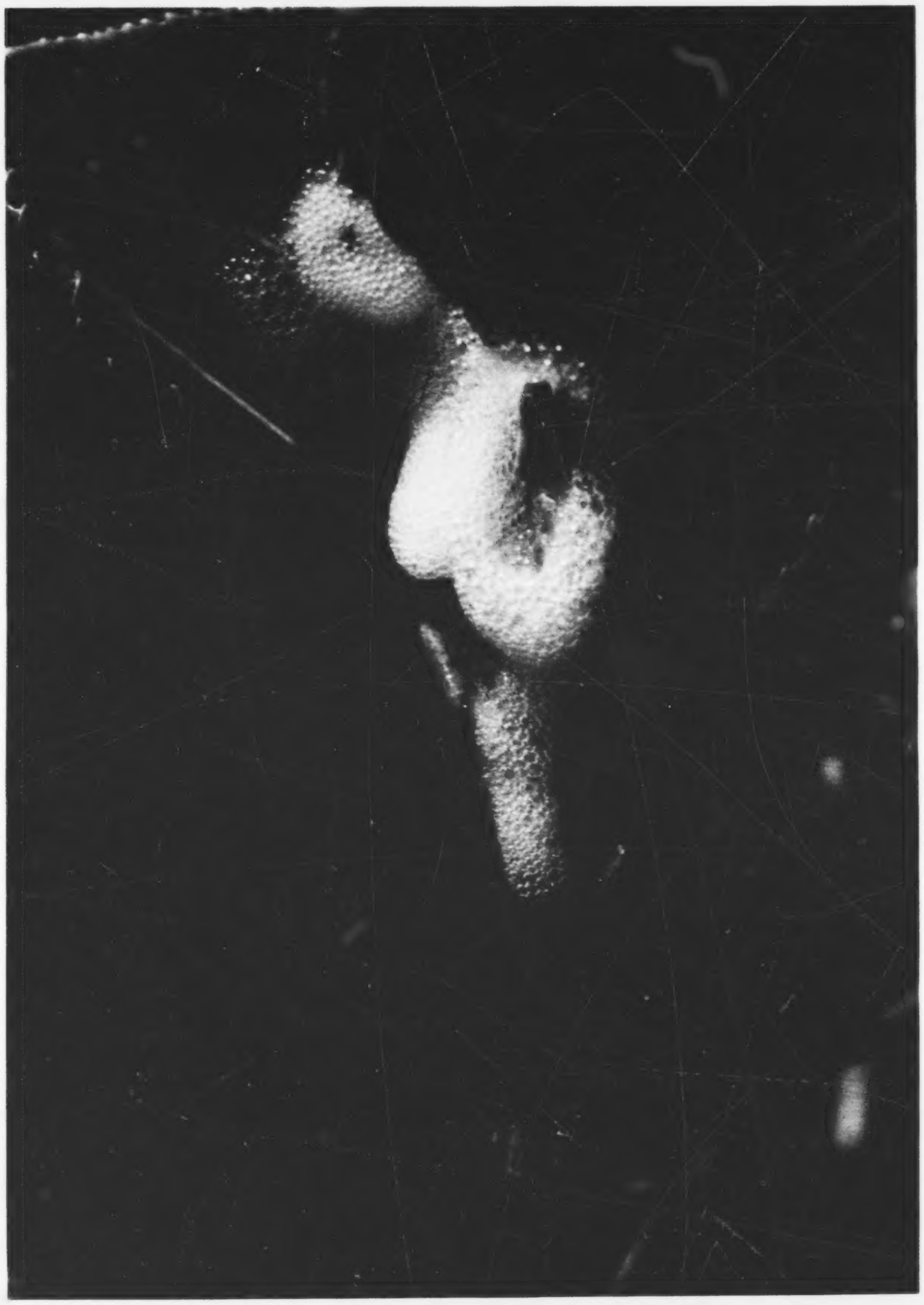
Look For —

- Frothy spittlemasses on the stem and branches.

Biology — The female spittlebug lays eggs in late summer on various plants. In spring, the nymphs emerge and feed on the stems and branches and produce spittlemasses.

Control —

Not needed.



Spittlemass of meadow spittlebug.

Tarnished Plant Bug
(*Lygus lineolaris*)

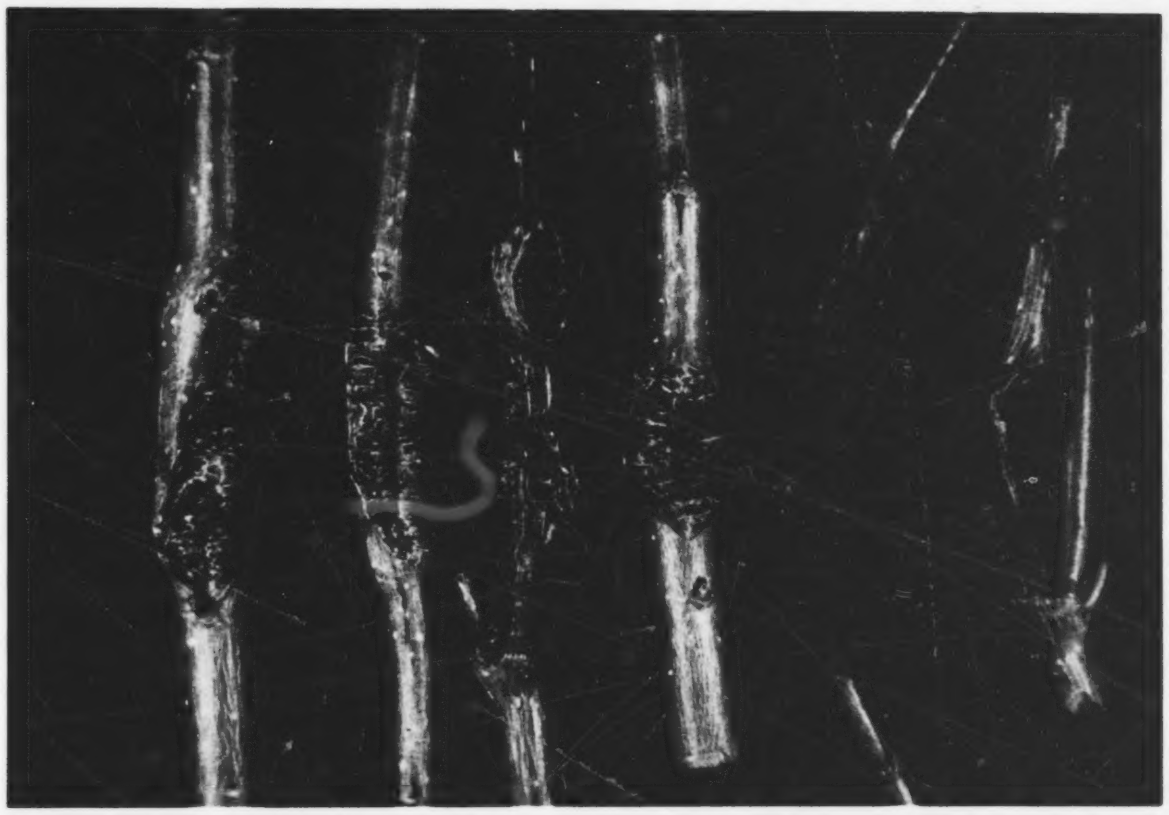
Importance — The adults and nymphs feed on young *Populus* stems and buds, causing lesions to form. Stems grow crooked or break over at the lesion. Injury is worst in clonal nurseries or where the 120 principal wild or agronomic hosts are abundant. Early harvesting of these crops may force insects onto *Populus* in search of food.

Look For —

- Lesions one-fourth inch to 2 inches long on the stems.
- Broken stems, bent over at a lesion.
- Small brownish plant bugs (less than one-fourth inch long) on the leaves or stems.

Biology — In the spring, the adults emerge from overwintering in litter and move to the hosts to feed. Eggs are inserted into the soft tissues of growing shoots, buds, or other tissue. The adults and later the newly hatched nymphs feed on the tissues, and their toxic saliva causes lesions to form. Feeding occurs throughout the summer. As weather cools in autumn, the adults move to the leaf litter and overwinter.

Tarnished plant bug injury.



Lesions caused by tarnished plant bug feeding.

Stem breakage at tarnished plant bug injury.

Monitoring — Inspect whips and young trees in early summer for tarnished plant bugs and in midsummer for the lesions. Examine 50 to 100 of each clone in the nursery; if 15 percent of whips in any clone have lesions, apply treatment or plan to control the following year.

Control —

- Spray heavily infested or injured clones with an insecticide recommended for plant bugs. Apply any time the bugs are present.
- Plant resistant clones.
- Do not plant susceptible clones next to corn, soybeans, or other agricultural crops that attract plant bugs.
- Salvage nursery stock by eliminating cuttings with lesions.
- Prune rooted cuttings below lesions before outplanting.

For Additional Information —

Sapio, Frank J.; Wilson, Louis F.; Ostry, Michael E. 1982. A split-stem lesion on young hybrid *Populus* trees caused by the tarnished plant bug, *Lygus lineolaris* (Hemiptera [Heteroptera]: Miridae). The Great Lakes Entomologist. 15: 237–246.

Wilson, Louis F.; Moore, Lincoln M. 1985. Vulnerability of hybrid *Populus* nursery stock to injury by the tarnished plant bug, *Lygus lineolaris* (Hemiptera: Miridae). The Great Lakes Entomologist. 18: 19–23.

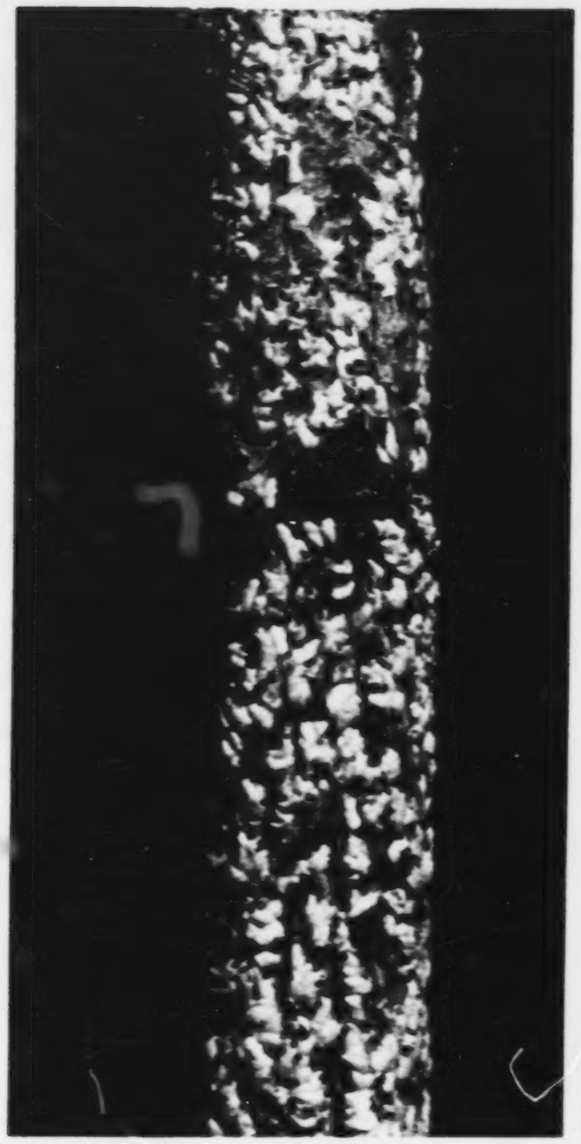
Scurfy Scale (*Chionaspis furfura*)

Importance — This insect sucks sap from leaves, branches, and trunks of *Populus* and various other tree species. Single trees or clumps of trees may become infested by a great number of scales, which kill shoots, branches, and occasionally the entire tree.

Look For —

- Dead and dying branches on trees.
- White to dirty gray, flattened, pear-shaped scales (one-eighth inch long) on the bark. Often in large numbers they appear as a whitish crust on branches and stems.

Biology — Eggs overwinter beneath the female scale, and crawlers hatch in spring. Nymphs settle down on the bark and grow into adults by late summer.



Cluster of scurfy scales on stem.

Monitoring — Inspect trees for scales any time of the year. Scales will usually infest isolated trees or clumps of trees. Consider control only when 10 percent of the trees are heavily infested and many branches die.

Control —

- Prune and destroy infested branches.
- Spray individual infested trees or stands for the crawlers with an insecticide recommended for scale insects.

Oystershell Scale (*Lepidosaphes ulmi*)

Importance — This insect sucks sap from the stems and branches of *Populus* and many other tree species. Outbreaks are sporadic; when populations are large, branches or scattered trees die.

Look For —

- Dead and dying branches or trees.
- Chestnut brown flat scales (one-eighth inch long), shaped like an oyster on the bark. Often in large clusters they appear as a crust on the bark.

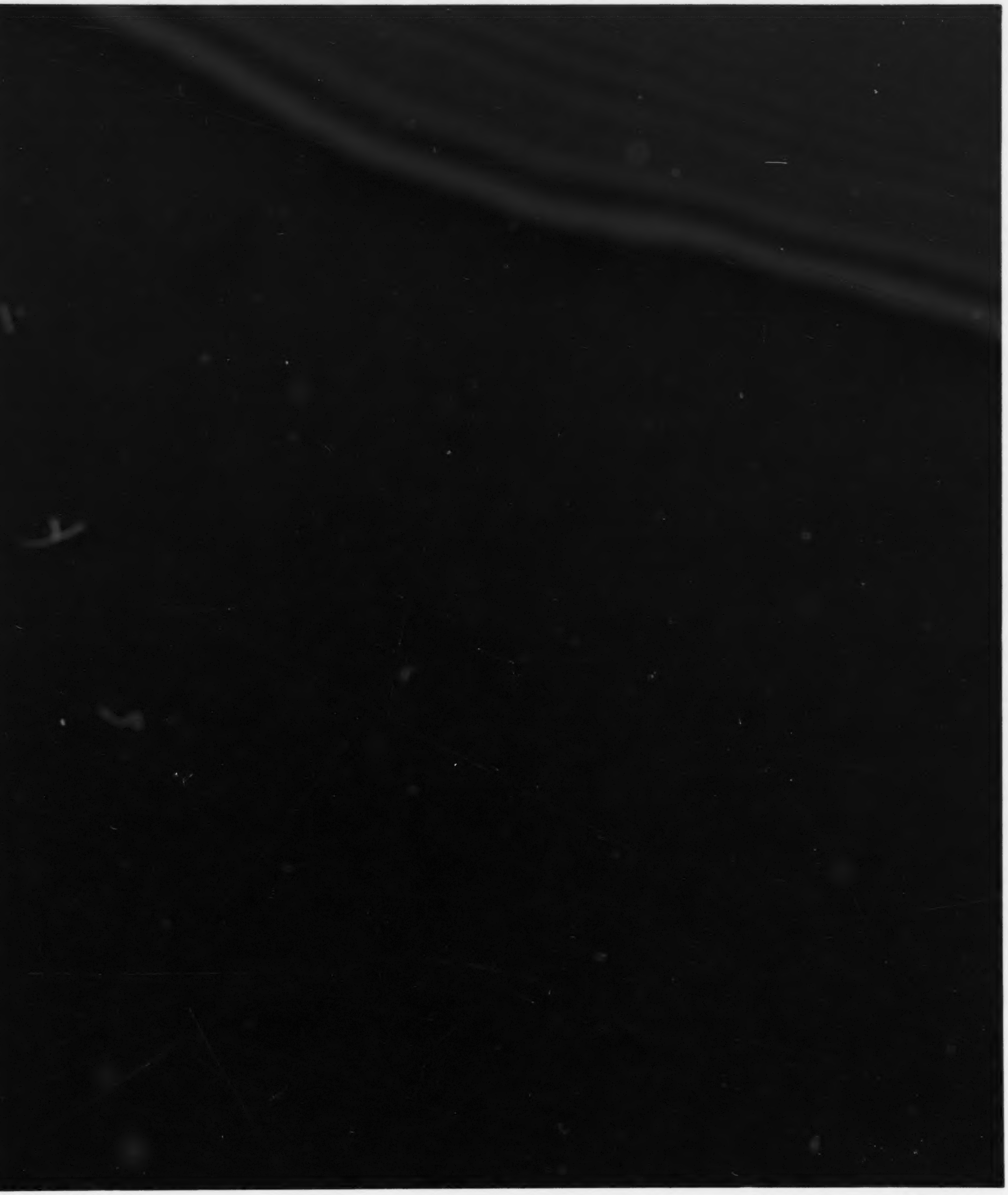
Biology — Eggs overwinter beneath the female scale, and crawlers hatch in spring. After nymphs settle down and feed, they grow into adults by summer. Each year one generation occurs in the North, two in the South.

Monitoring — Inspect trees for scales any time of the year. Consider control when 10 percent of the trees are heavily infested and shoots are dying.

Control —

- Prune and destroy infested branches.
- Spray individual infested trees with an insecticide recommended for scale insects.

Cluster of oystershell scales.



ystershell scales.

Miscellaneous Leaf-feeding Aphids (Aphidae)

Importance — Nymphs and adults feed on the undersides of leaves and on the new stems of *Populus*. Some leaves are discolored or killed. The insect is unsightly on ornamental trees but does not damage commercial trees.

Look For —

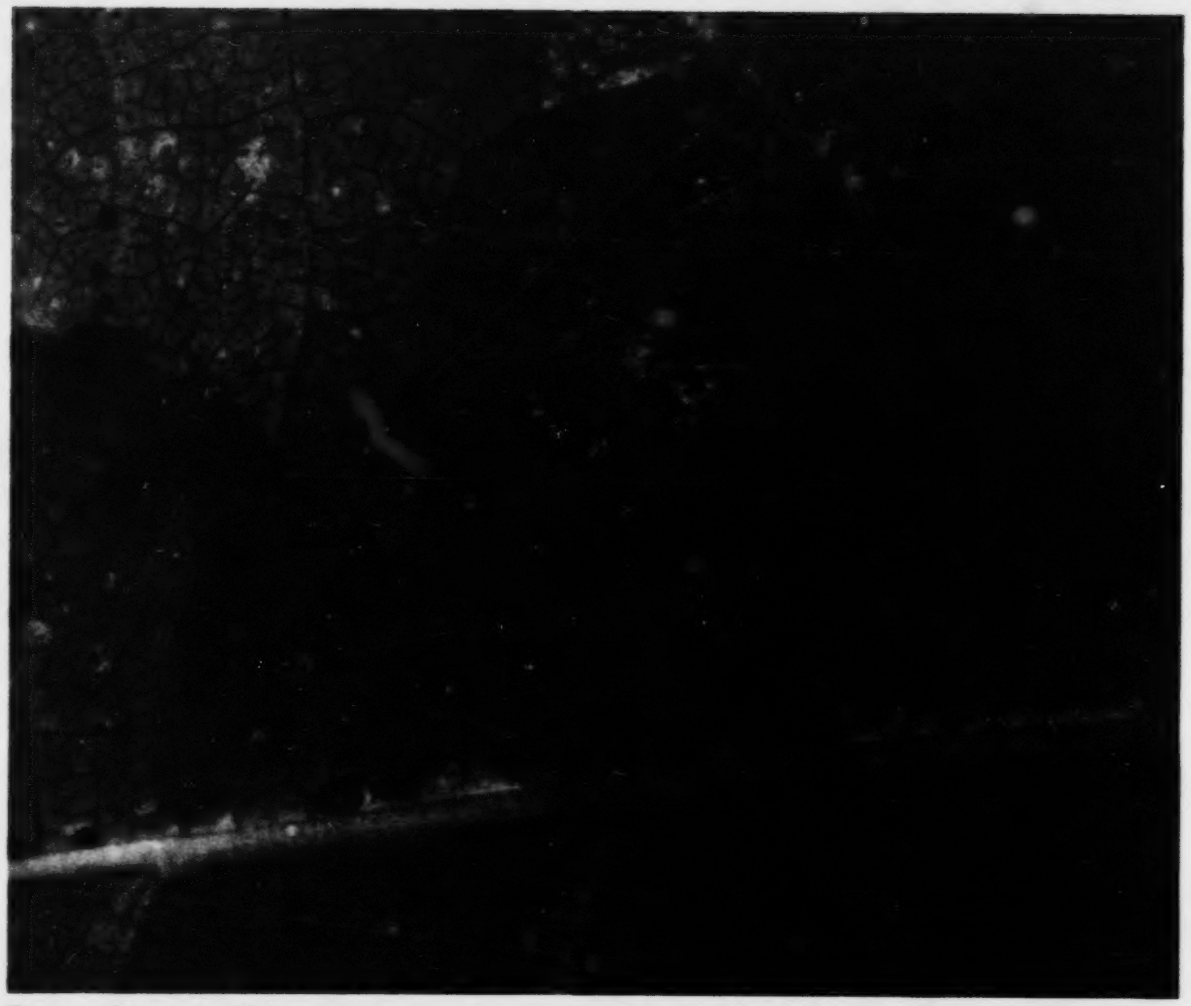
- Colonies of brown-to-black aphids on the newly developing stems or along the veins on the leaf undersurface in midsummer. There may be a few hundred aphids in the colony, which is often attended by ants.

Biology — Aphids move onto developing leaves and stems in spring and feed and reproduce throughout the warm season. Adults overwinter.

Monitoring — Inspect shoots and leaves in midsummer to late summer in nurseries and young plantings. Control is not recommended unless more than 75 percent of the leaves have colonies or unless appearance is important.

Control —

- Not normally necessary because this insect is usually kept in check by predators.
- If needed, spray colonies with an insecticidal soap or other chemical insecticide recommended for sucking insects.



Cluster of brown aphids.

Spotted Poplar Aphid (*Aphis maculatae*)

Importance — Nymphs and adults feed on the newly developing terminal shoots of nursery stock and young plantation trees. Heavily infested leaves curl; some turn black and drop off. Feeding may cause a small amount of height-growth loss.

Look For —

- Dense colonies of perhaps thousands of blue-black spotted aphids on shoot tips in late July to leaf fall.
- Distorted, curled, or dead leaves on terminals.

Biology — Migrants move onto *Populus* terminals in the spring and feed and reproduce. Large colonies form, which may exceed 2,500 individuals by late summer. The aphids generally move to dogwood trees to overwinter.

Monitoring — Inspect whips in nurseries and outplanted trees for the first 2 to 3 years. Examine 50 to 100 terminal shoots and treat infested areas if more than 50 percent of terminals are infested. If lady bird beetles or other native predators are abundant, **do not control.** This insect may need to be monitored by specific clone because clones differ widely in susceptibility to attack. Clones of *Populus* x *jackii* are especially susceptible.

Control —

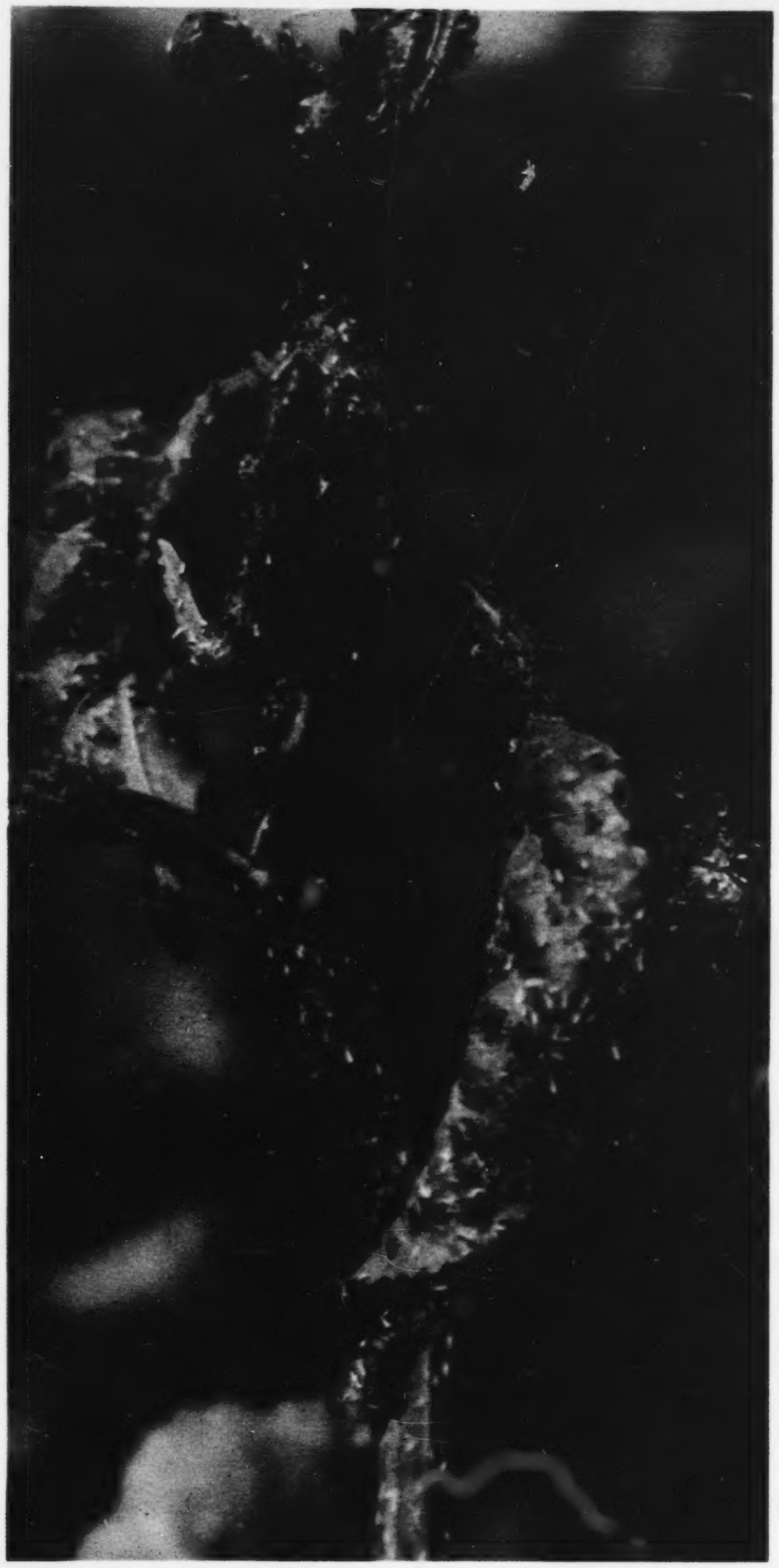
- Plant aphid-resistant trees.
- Avoid planting near dogwood trees.
- Spray infested terminals with an insecticidal soap or a contact insecticide recommended for sucking insects. **Do not** spray insecticides if predators are feeding on aphids.

For Additional Information —

Wilson, L. F.; Moore, L. M. 1986. Preference for some nursery-grown hybrid *Populus* trees by the spotted poplar aphid and its suppression by insecticidal soaps (Homoptera: Aphididae). The Great Lakes Entomologist, 19:21-26.

Aphids feeding on stem.

Aphids feeding on leaf.



Injury of shoot caused by spotted poplar aphids.

Leafhoppers (Cicadellidae)

Importance-Leafhoppers feed by piercing plant tissues with their mouth parts and sucking the juices. Heavy feeding during hot, dry periods of the summer, when trees are in full foliage, can reduce vigor and growth. Several leafhoppers are known vectors of viruses that affect *Populus*.

Look For—

- Bullet-shaped leafhoppers up to one-half inch long — of various colors depending on the species.
- Young trees with unnatural leaf yellowing.

Biology — Leafhoppers spend the winter as eggs, nymphs, and adults. Nymphs and adults overwinter under debris in woodlands and along ditch banks. Eggs are laid in clusters between the upper and lower leaf surfaces.

Monitoring — Examine nurseries and plantation trees for leafhoppers from early spring to late summer. If some trees show yellowing from virus infection, consider control.

Control—

- Plant resistant clones.
- Remove debris from nurseries and plantations.
- Apply an insecticide recommended for leafhoppers.

Miscellaneous Insects and Mites

Miscellaneous Insects and Mites

Gall Insects
Several Groups

Importance — Several insects and mites cause swellings or galls on the stems, shoots, leaves, and petioles of *Populus*. Most galls cause local injury that does not affect tree growth or survival. A few galls cause premature leaf fall or stem breakage.

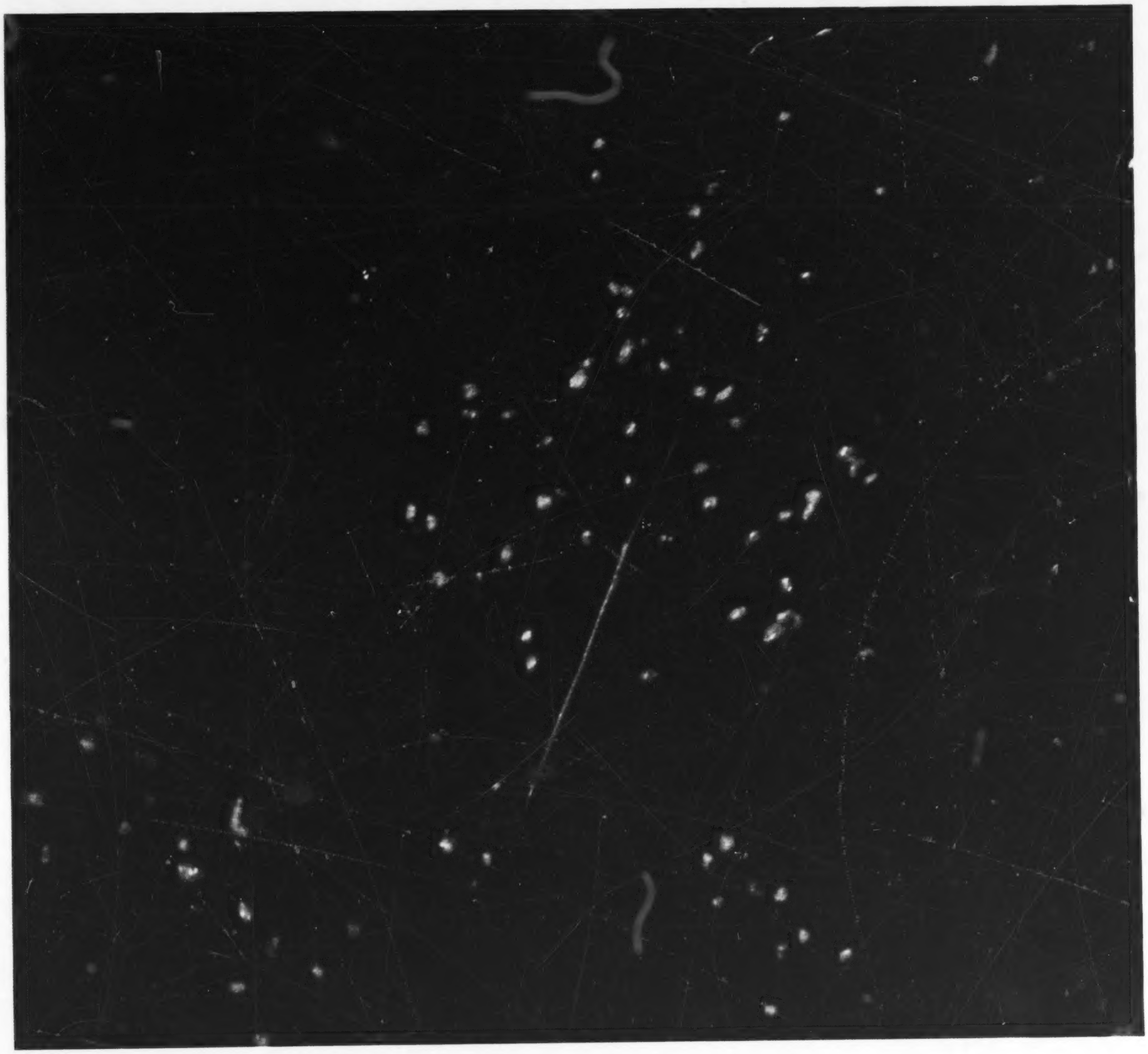
Look For —

- Round, oval, or irregular swellings on the stems, shoots, leaves, or petioles.

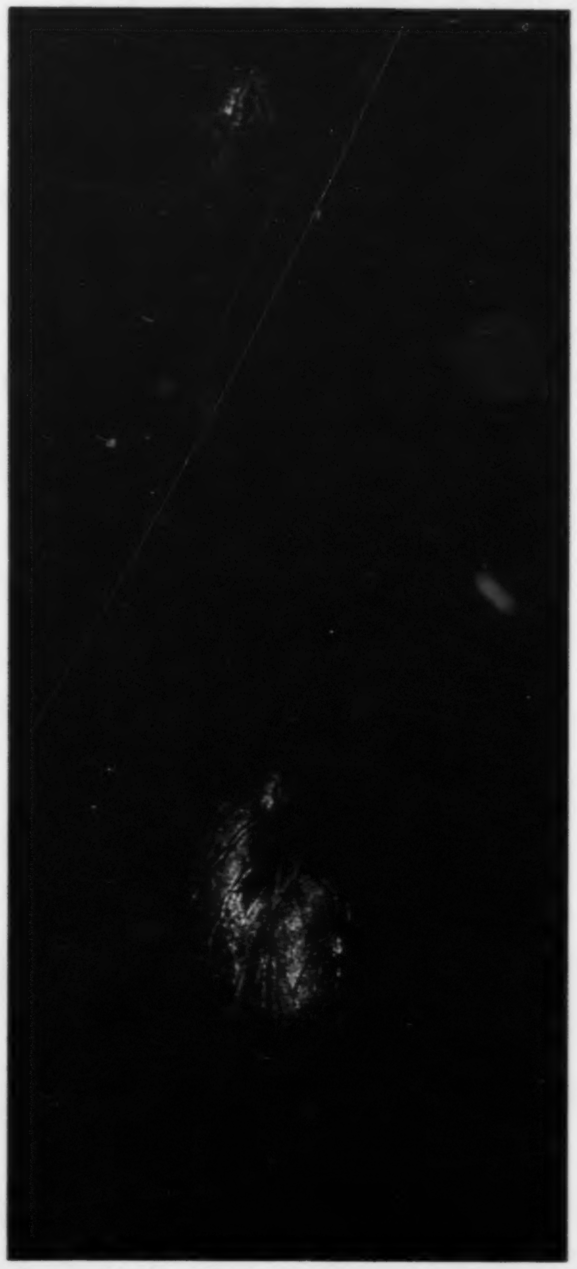
Biology — Galls are caused by various organisms such as aphids, midges, flies, and mites; each organism has a specific life cycle.

Monitoring — Check trees for galls. Consider control only if the pest is killing shoots or trees.

Control — Seldom recommended. If control is needed, identify pest and follow control recommendations for it.



Leaf galls.



Stem galls. ▲

◀
Leaf galls.

▼Petiole gall.

Snowy Tree Cricket (*Oecanthus fultoni*)

Importance — Female crickets injure new shoots by laying eggs in slits cut in the bark. Weakened shoots break over or die; injured trees grow crooked. Nymphs and adult crickets cause insignficant injury when they feed on foliage.

Look For —

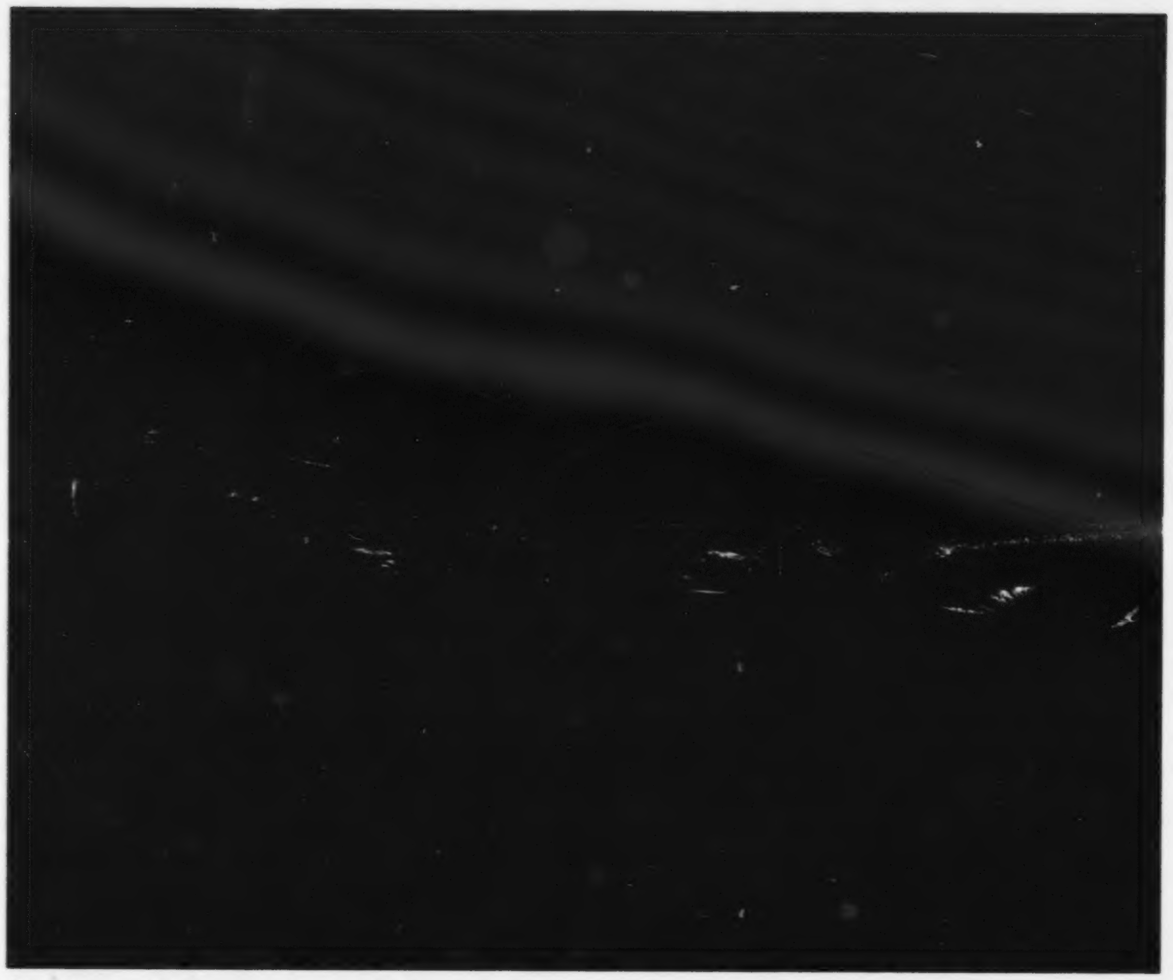
- Broken over or dead branches.
- Longitudinal slits up to 2 inches long, resembling a zipper, located on the new growth or at the juncture of a broken or dead branch.
- Light green slender nymphs or adult crickets on the foliage.

Biology — Female crickets mature in late summer and lay their eggs in new shoots after cutting a deep slit in the tissues. The eggs overwinter and nymphs emerge when the weather warms in spring. Nymphs feed throughout the spring and summer.

Monitoring — Inspect nursery whips on young plantings for shoot injury throughout the growing season. Examine 50 or more trees; if leaders are broken on 10 percent, consider treatment.

Control —

- In nurseries, prune and destroy shoots with eggs.
- Spray infested nurseries or plantations for nymphs or adults with an insecticide recommended for foliage-feeding insects.



Egg slit made by snowy tree cricket.

Adult snowy tree cricket.

Cicadas (Cicadidae)

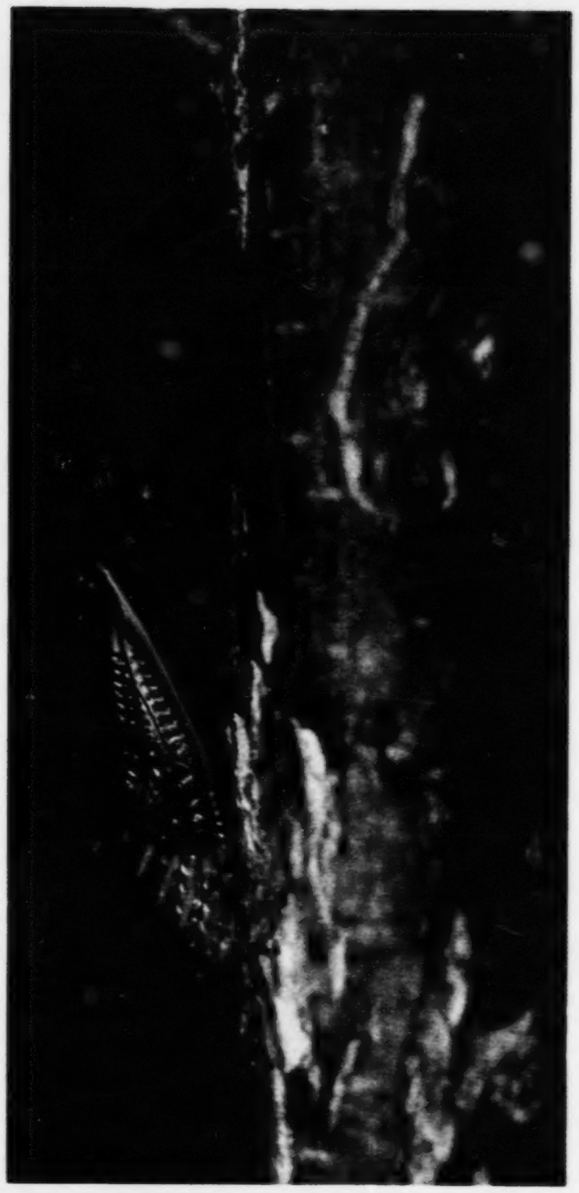
Importance — Cicada adults cause no visible damage when they feed. Female cicadas injure shoots and branches of trees by laying eggs in slits in the bark. Terminal shoots may break over or die. Young trees, especially, may be heavily damaged, but older trees may only lose a few branches when infested. Dogday cicadas appear yearly; the periodical cicada is important at 17-year intervals in the North and 13-year intervals in the South.

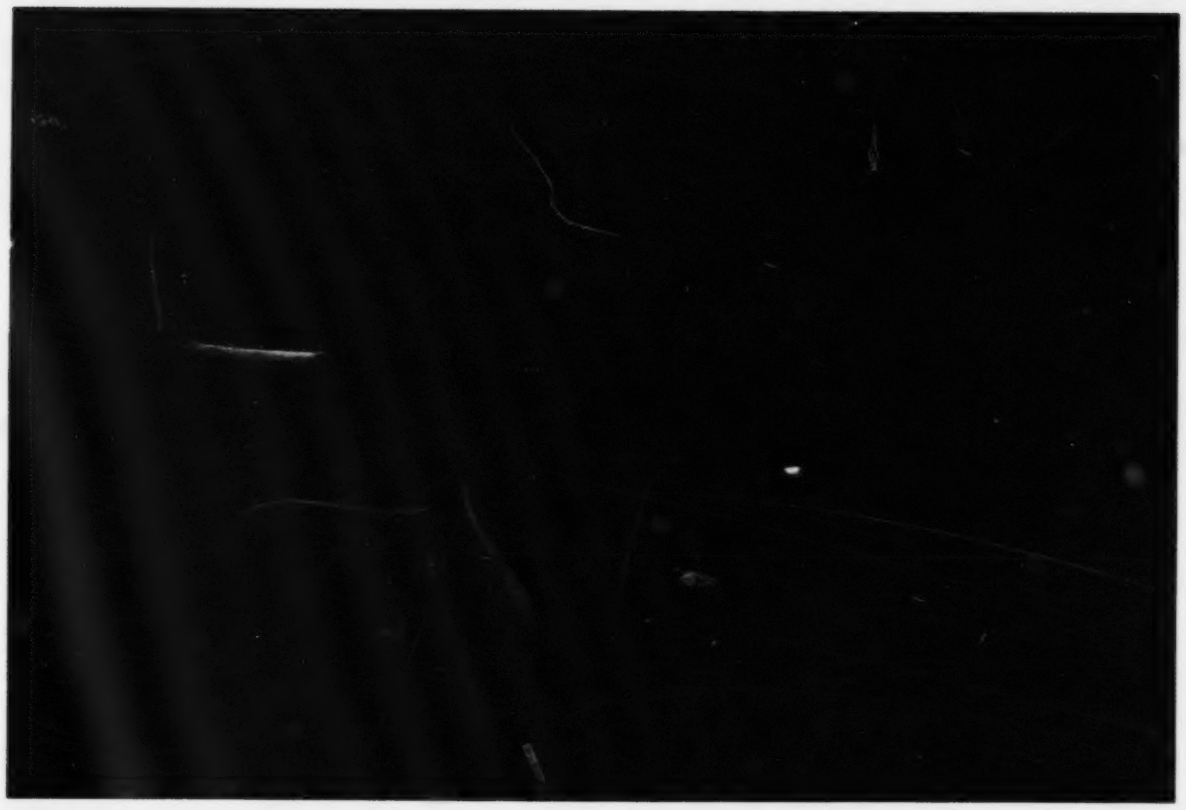
Look For —

- Broken over or dead branch tips.
- Slits up to 3 inches long on the newest growth or at the juncture of a broken or dead branch tip, with fibrous material protruding from the slits.
- Stocky green to black boat-shaped insects 1 to 2 inches long on the trees. Males emit a high-pitched whine that may help you locate them.

Biology — Cicadas live from 2 to 17 years, mostly as nymphs underground, during which time they feed on roots. When mature, normally in April or May, the nymphs emerge from the soil at night and move to nearby trees to moult to the adult stage. The females lay eggs in the shoots of trees and shrubs; when the nymphs emerge, they drop to the ground to seek suitable roots on which to feed. Adults may live 5 to 6 weeks.

Dogday cicada.


Periodical cicada.


Egg slit made by cicada.

Monitoring — Inspect whips or young plantings in early summer for shoot injury. Listen for the whine of the males, which will be incessant when insects are abundant.

Control —

- In nurseries, prune and destroy shoots with eggs.
- Chemical control is usually impractical.

Cottonwood Leafcurl Mite (*Aculus lobulifera*)

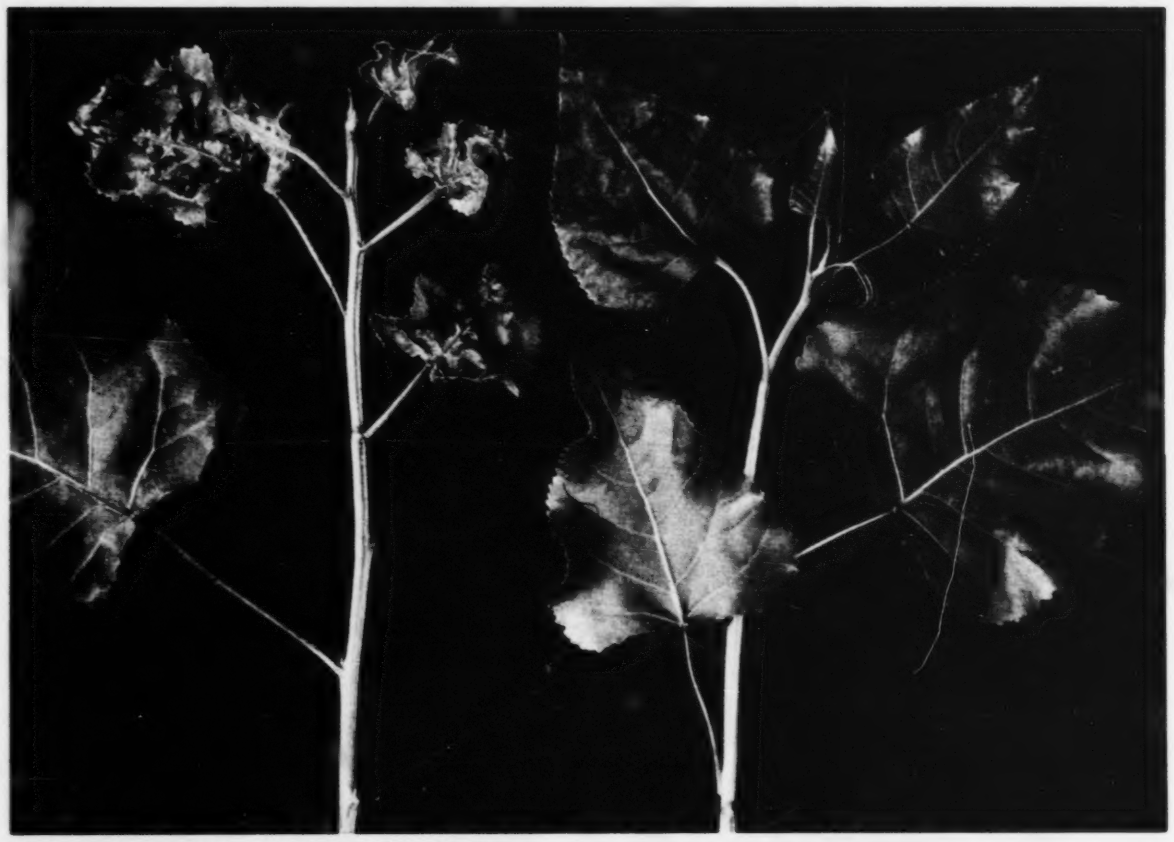
Importance — This mite feeds on terminal foliage and stems, causing stunting; malformation of leaves, terminal tips, and buds; and loss of immature foliage. Heavy attacks can reduce growth and vigor of young *Populus* in nurseries and plantations.

Look For —

- Leaves missing on terminal shoot.
- Stunted crinkled leaves with red veins and purplish-green brittle blades; scaley, brown petioles.
- Minute four-legged straw-colored mites that resemble dust flecks on the leaves. Use a hand lens to see the mites.

Biology — Most leafcurl mites perish with leaf fall. However, some mites find hibernation shelters in bark crevices, branch scars, and at the base of infested trees. In spring, these mites leave their shelters, feed, and lay eggs on the new foliage. Large populations develop rapidly during hot, dry spells.

Monitoring — Inspect young nursery and plantation stock for mites from June to October. Treat if 5 percent of the stock becomes infested in nurseries. Consider control in plantations only if more than half of the trees are infested.



Foliage damaged by cottonwood leafcurl mite (left) compared to normal foliage (right).

Control —

- Use frequent overhead irrigation in nurseries.
- Drench trees in infested area with a recommended miticide between June and October to kill adults. Apply a follow-up treatment within 2 weeks to control newly hatched mites.

Glossary

References

Forest Service Offices

Glossary

Abiotic — Nonliving disease agent.

Ascospore — A spore produced in the sexual or perfect state of an ascomycete fungus.

Asexual — Imperfect state of a fungus.

Biotic — Living agent of a disease.

Blight — Rapid death or dieback.

Blotch — Large, irregular necrotic area on a leaf caused by a pathogen or insect.

Broom — An abnormally dense mass of tree branches.

Bt (*Bacillus thuringiensis*) — A bacterium used as biological disease agent to control larvae of some insect species.

Canker — A localized dead portion of the cambium and bark of branches and stem of a tree.

Chlorosis — Yellowing of foliage.

Chrysalis — The pupal stage of a butterfly.

Conidia — Asexual fungus spores.

Dieback — Progressive death of branches from the tip downward.

Disease — Unfavorable change in the function or form of a plant that adversely affects its health.

Egg niche — Cavity in plant tissue made by an adult insect to hold eggs.

Flag — A single dead branch with dead foliage remaining.

Frass — Insect excrement or mixture of destroyed plant tissue and excrement.

Fruit body — A reproductive structure of a fungus that produces spores.

Gall — Swelling of plant tissues caused by certain fungi, bacteria, viruses, insects, mites, or nematodes.

Gallery — A tunnel made in plant tissue by an insect larva.

Girdle — Damage that completely encircles a tree stem, often killing the portion above.

Hyphae — The filaments of a mycelium.

Inoculum — Spores, mycelium, or other propagules of a pathogen that can infect a plant, causing disease.

Larva — The feeding stage of certain insects that emerge from the egg stage; often called caterpillar, maggot, slug, or grub.

Lesion — An injury or wound on a plant.

Mycelium — Mass of hyphae that forms the fungus body.

Necrosis — Death of plant cells resulting in a darkening of the tissues.

Pathogen — An organism that causes disease.

Pupa — Quiescent stage of an insect following the larval stage; may be in a cocoon.

Serpentine mine — Snake-like burrow inside leaf caused by an insect larva.

Signs — Visible evidence of a pathogen or insect.

Skeletonizing — Insect feeding on leaf tissues, removing most interveinal tissue but leaving most of the veins intact.

Spore — Reproductive structure of a fungus.

Stools — Poplar plants grown in nursery propagation beds. Shoots are harvested annually for producing hardwood cuttings, forming what are commonly referred to as stools.

Symptom — Visible response of a plant to a pathogen or an insect.

Tubercle — A small, solid pimple or button on caterpillars often covered with hair.

Wood shavings — Woody slivers cut by larvae when constructing galleries.

References

Dickmann, Donald I.; Stuart, Katherine W. 1983. The culture of poplars in Eastern North America. East Lansing: Michigan State University, Department of Forestry. 168 p.

Food and Agriculture Organization of the United Nations. 1979. Poplars and willows in wood production and land use. FAO For. Ser. 10. Rome: Food and Agriculture Organization of the United Nations. 328 p.

Hansen, E. A. 1981. How to grow hybrid poplars. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 5 p.

Hansen, Edward A., comp. 1983. Intensive culture: 12 years research. Gen. Tech. Rep. NC-91. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 155 p.

Hansen, Edward; Moore, Lincoln; Netzer, Daniel; Ostry, Michael; Phipps, Howard; Zavitkovski, Jaroslav. 1983. Establishing intensively cultured hybrid poplar plantations for fuel and fiber. Gen. Tech. Rep. NC-78. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 24 p.

Zavitkovski, J.; Strong, T. F. 1982. How to grow and use hybrid poplar firewood. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 5 p.

Forest Service Offices

Region 1 — Northern

USDA Forest Service
State & Private Forestry
Forest Pest Management
Federal Building
P.O. Box 7669
Missoula, MT 59807
(406) 329-3511
FTS 585-3511

Region 2 — Rocky Mountain

USDA Forest Service
State & Private Forestry
Forest Pest Management
11177 W. 8th Ave.
Box 25127
Lakewood, CO 80225
(303) 236-3213
FTS 776-3213

Region 3 — Southwestern

USDA Forest Service
State & Private Forestry
Forest Pest Management
Federal Building
517 Gold Ave. S.W.
Albuquerque, NM 87102
(505) 842-3292
FTS 476-3292

Region 4 — Intermountain

USDA Forest Service
State & Private Forestry
Forest Pest Management
Federal Building
324 25th St.
Ogden, UT 84401
(801) 625-5257
FTS 586-5257

Region 5 — Pacific Southwest

USDA Forest Service
State & Private Forestry
Forest Pest Management
630 Sansome St.
San Francisco, CA 94111
(415) 556-6520
FTS 556-6520

Region 6 — Pacific Northwest

USDA Forest Service
State & Private Forestry
Forest Pest Management
319 S.W. Pine St.
P.O. Box 3623
Portland, OR 97208
(503) 221-2877
FTS 423-2727

Region 8 — Southern

USDA Forest Service
State & Private Forestry
Forest Pest Management
1720 Peachtree Road N.W.
Atlanta, GA 30367
(404) 347-2989
FTS 257-2989

USDA Forest Service
State & Private Forestry
Forest Pest Management
2500 Shreveport Hwy.
Pineville, LA 71360
(318) 473-7160
FTS 497-7160

USDA Forest Service
State & Private Forestry
Forest Pest Management
200 Weaver Blvd.
Asheville, NC 28804
(704) 672-0625
FTS 672-0625

Region 10 — Alaska

USDA Forest Service
State & Private Forestry
Forest Pest Management
Federal Office Building
Box 1628
Juneau, AK 99802
(907) 261-2575
FTS 907-261-2575

Northeastern Area

USDA Forest Service
State & Private Forestry
Forest Pest Management
370 Reed Road
Broomall, PA 19008
(215) 461-3252
FTS 489-3252

USDA Forest Service
State & Private Forestry
Forest Pest Management
Louis C. Wyman For. Sci. Lab.
P.O. Box 640
Durham, NH 03842
(603) 868-5719
FTS 834-5765

USDA Forest Service
State & Private Forestry
Forest Pest Management
180 Canfield St.
P.O. Box 4360
Morgantown, WV 26505
(304) 291-4133
FTS 923-4133

USDA Forest Service
State & Private Forestry
Forest Pest Management
1992 Folwell Ave.
St. Paul, MN 55108
(612) 649-5261
FTS 777-5261

Pesticide Precautionary Statement

Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key — out of the reach of children and animals — and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency, consult your county agricultural agent or State extension specialist to be sure the intended use is still registered.

CAUTION:
PESTICIDES